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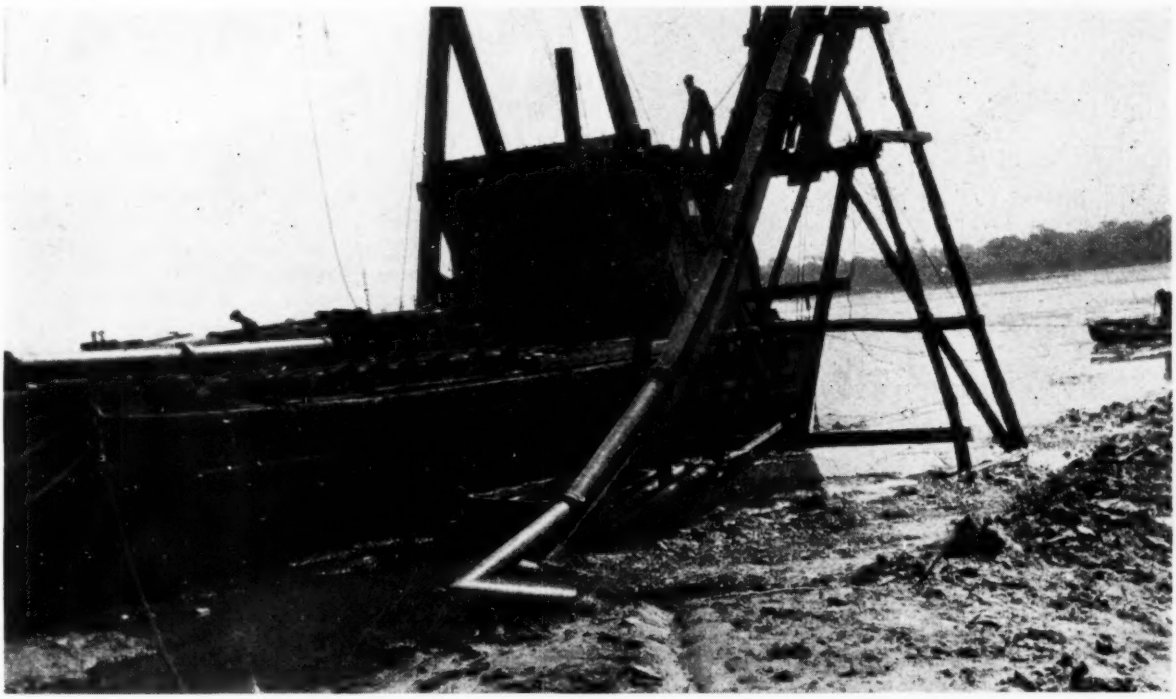

Tower and Chute for Placing the Pipe

Laying a 8,500 Feet Submarine Pipe Line

Methods and Costs of Constructing a Main in Casco Bay from Portland, Me., for Furnishing a Water Supply to Fort McKinley on Great Diamond Island

By HARRY U. FULLER

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THE work consisted in laying a 12 in. main 1,700 ft. long between the mainland and Mackworth Island and an 8 in. main 6,800 ft. long between Mackworth Island and Great Diamond Island.

The contour of the bottom crossed the mouth of a river with a depth of 30 ft. and for about a mile varied between 15 and 25 ft. in depth. The material is blue clay overlaid with from 1 to 2 ft. of silt. Soundings were made over the entire length of the line with a 40 ft. piece of 1 in. pipe. There was no difficulty in churning this sounding rod 6 ft. into the underlying clay.

The pipe was purchased by the Portland Water District from the U. S. Pipe & Foundry Co. and delivered to the contractor on a convenient wharf.

The Bids.—Bids were received on April 29, 1929. They were as follows:

	Bay State Dredging and Contracting Co.		Merritt Chapman and Scott		Bennett Contracting Corp.	
Quantities	Unit	Total	Unit	Total	Unit	Total
1,700 ft. 12 in.	$10.28	$17,476	$11.00	$18,700	$13.50	$22,950
6,800 ft. 8 in.	9.20	62,560	8.60	58,480	7.65	52,020
Total		$80,036		$77,180		$74,970

The contract was let to the lowest bidder. He had previously laid a 16 in. submarine line in Portland Harbor and had done other submarine work, thereby demonstrating his ability.

Construction Equipment.—The contractor provided a lighter 28 ft. x 80 ft. having an 80 ft. boom for handling the pipe and pipe chute; a lighter 20 ft. x 54 ft. rigged with a derrick for excavating and back filling and a pile driver 24 ft. x 54 ft. The lighter used for excavating was provided with outrider pontoons to give greater stability.

On a previous similar job this contractor had laid the pipe by means of curved chute suspended between two lighters.

On this job, he made a change in the method of holding the chute. He built a tower of timbers properly trussed which rested on the bottom of the bay and extended above high water. Attached to this tower was the curved chute used for laying the pipe.

The legs of the tower were fastened to skids which formed the feet of the structure. In general appearance, this apparatus suggested a giraffe with his four legs standing well apart.

This tower spanned the trench which had been pre-

The Lighter for Excavating Had Outrider Pontoons

viously dredged. The lower end of the chute extended downward into the trench, and served to smooth off any irregularities left by the bucket in dredging.

The pipe laying chute was about 90 ft. long and of such curvature that the pipe did not exceed a defection of 10 degrees. The upper end of the chute was tangent to the curve to allow the joints to be made up straight. The lower end of the chute was so curved as to allow the pipe to slide off into the trench without straining the joints.

Platforms for workmen, making joints, were provided near the top of the "giraffe."

The "giraffe" was a complete success in every respect. There was no movement due to wave action and during rough weather it was not necessary to lower the pipe and pick it up later with the accompanying undersirable movement of the joints. The contractor has applied for a patent on this apparatus.

The dredge preceded the pipe layer by only a shor distance, digging a trench 5 ft. deep and about 10 ft. wide on the top and perhaps 5 ft. wide on the bottom.

The dredging was done with an orange peel bucket. The material was deposited on the bottom at one sid of the trench and later handled back into the trench.

The large lighter was kept beside the pipe layin chute and placed the successive sections of pipe in posi tion for jointing. It also moved the giraffe by liftin the front end and dragging it ahead as each section o pipe was laid.

Laying the Pipe.—The approaches to the submarin line having been laid by ordinary land methods to a half-tide point, and the dredge having completed some thing over 100 ft. of trenching at high tide, the "giraffe" was set in position about 50 ft. outside of the land end of the pipe.

It was found that some time could be saved by joint ing two pieces of pipe on the deck of the lighter and hoisting the two pieces as a unit to the pipe laying chute. This was made possible by the presence of the large and powerful lighter with an 80 ft. boom. Furthermore, the lighter by this method could move the giraffe 24 ft. at each movement.

Two pieces of pipe were placed in the chute and the lead joints poured and calked. The pipe after sliding down the chute was then scooted ashore.

This operation is related to the use of a cableway with the whip from the boom forming the cable and the pipe hanging from a snatch block riding on the whip. By this method the end of the pipe was carried toward shore as successive pieces of pipe were joined in the chute until the end of the submarine pipe was 6 ft. from the land pipe. This opening was left to allow a plug to be leaded in the end of the submarine line for testing purposes.

It was also helpful to allow the entire line to be laid

The "Giraffe" in 20 Ft. of Water

and back-filled in order that any settlement that took place could occur before the ends were completed.

From this point, the pipe laying consisted of adding successive lengths to the line in the chute and pulling the giraffe along.

Time Required.—The work was started on June 10 and completed September 18, making 100 days of elapsed time and averaging 85 feet of pipe daily.

Laying the 12 in. pipe required 17 working days in 31 elapsed days with an average of 100 ft. daily for working days and 60 ft. daily for elapsed days. The best day's work was 168 ft.

Laying the 8 in. pipe required 30 working days and 41 days of elapsed time with an average of 222 ft. daily for working days and 162 ft. daily for elapsed days. The best day's work was 408 ft.

Testing.—The specifications required that the leakage in the line should not exceed 4 gal. per linear foot of pipe joint per 24 hours at 150 lb. pressure. For the 12 in. line this worked out to be 1.67 gal. per minute.

The first test was made on Saturday and showed 1.83 gal. per minute. Monday morning a second test showed 1.33 gal. per minute and on Tuesday the leakage was 1.19 gal. per minute.

This progressive tightening of the line confirmed previous experience.

For the 8 in. line, the allowable leakage worked out to be 4.6 gal. per minute. The test was made in the afternoon and showed a leakage of 1 gal. per minute. A second test an hour later showed no leakage. The hand pump used in testing held the pressure gage at about 150 lb. with no movement.

A gate was then closed between the pump and the line and the gage read 152 lb. It was left in this condition at the end of the day's work and on arrival the next morning on the job, it was found that the gage read 105 lb. Thus, it appeared that the line was bottle tight, a somewhat remarkable showing for a watermain of this type.

Cost.—On the 12 in. line 170 ft. of foundation cost $3,263, or $19.00 per linear foot.

The 377 ft. of 12 in. pipe laid by land methods on the flats between high water and mean-tide cost $2,473 or $6.60 per linear foot.

The 1,820 ft. of 12 in. submarine line exclusive of foundation cost $35,050, or about $19.00 per linear foot.

The following tabular statement shows the details of the above figures.

Cost of 12 In. Submarine Line

	1,820 Ft. 12 In. Sub. Line	377 Ft. 12 In. Line on Flats	170 Ft. Pipe and Cap Foundation	2,197 Ft. Total
Cost of pipe	$ 7,252	$1,097	.....	$ 8,349
Labor and rent of equipment	24,476	1,208	$1,560	27,244
Other materials and supplies	1,659	72	1,559	3,290
Engineering and overhead	1,663	96	144	1,903
Total	$35,050	$2,473	$3,263	$40,786
Cost per foot	$19.25	$6.57	$19.20	$18.50

The 8 in. line cost $68,705 or $10.30 per linear foot. The details of cost are shown in the following table.

Cost of 6,660 Ft. of 8 In. Submarine Pipe

Feet		Cost	Per Foot
5,732	New flexible joint pipe	$12,830	$2.20
928	Old flexible joint pipe	1,429	1.72
6,660	Total pipe	$14,259	$2.14

Cost of 6,660 Ft. of 8 In. Submarine Main

	Cost	Per Foot
Cost of pipe	$14,259	$2.14
Labor and rent of equipment	51,465	7.70
Other materials and supplies	451	.07
Engineering and overhead	2,530	.39
Total	$68,705	$10.30

Raymond F. Bennett, President of the Bennett Contracting Corporation, had personal charge of the execution of this work. Roy H. Beattie was consulting engineer, and Eben L. Parrott was inspector of construction. The writer was engineer for the Portland Water District.

Acknowledgment.—The foregoing is an abstract of a paper presented Sept. 25 at the 49th annual convention of the New England Water Works Association.

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Installing a Flexible Joint Pipe River Crossing

An important feature of the distribution system of Buffalo, N. Y., is the flexible joint cast iron pipe under river crossings in navigable streams. There are three of these, all of 16-in. diameter pipes. The first was laid across the City Ship Canal at Harbor Turnpike in 1918 and is 240 ft. long. The other two were laid across the City Ship Canal and Buffalo River at South Michigan Ave., and are respectively 250 ft. and 404 ft. long from shore connection to connection. The method of assembling and installing these mains was described by Wm. H. Grotz, Assistant Engineer, Division of Water, in a paper presented before the New York Section of the American Water Works Association. The note following is taken from his paper.

The pipes were class "B" with the Metropolitan type ball and socket joint, in which the lead remains in the bell when the joint is deflected. A trench across the river bottom was excavated by dredge to a depth of 37 ft. below mean low water level between harbor lines, with the shore ends rising on an easy curved slope. The pipes were put together in sections on a flat scow, and as each joint was poured and caulked, it was deflected and another pipe added. Those sections which were to lie in the bottom of the river were made up of pipes 12 ft. long, while those to be used at the shore ends were 6-ft. lengths, this to provide greater curvature. The last pipe at each end was fitted at the top end with a standard bell for connection with land pipes.

Flat scows were lashed end to end the entire width of the river and the pipes transferred to these by a derrick scow. The entire length was thus made up and suspended to the sides of the scows by rope lashings. Rope lines were then attached to alternate pipes and fastened about snubbing posts, and when ready to lower, these lines were slacked off slowly about the snubbing posts, permitting the pipe to settle slowly to the bottom, the center portion of the main being allowed to settle first. When the main rested on the bottom, the ends above water were capped and an air test of 120 lbs. applied. A diver followed up the joints during the test, caulking any joint found to be leaking. The shore ends were then connected in the usual manner, and a 5-ft. fill of good earth was then deposited over the pipe trench in the river bed for protection. These lines are in service constantly and have given no trouble since laid, and are about the tightest mains in the system.

Visitors, Citizens, Admire Glassboro Sewage Plant

VELVETY lawns, beds of flowers of brilliant hue, a wooded background and an attractive access road distract the attention of the casual visitor at the Glassboro, N. J., sewage treatment plant from its more import function in the community. The accompanying illustrations convey some of the impressions such a visitor might carry away.

The plant, which was put in service in 1926, is situated in a dense wood on the banks of the Chestnut Run branch of Big Timer Creek, about 1½ miles northwest of the center of the borough and about ¼ mile from the nearest road. It consists of an Imhoff tank, open sludge-drying beds, a sprinkling filter with a siphon dosing tank, a chlorinating chamber and a final settling tank.

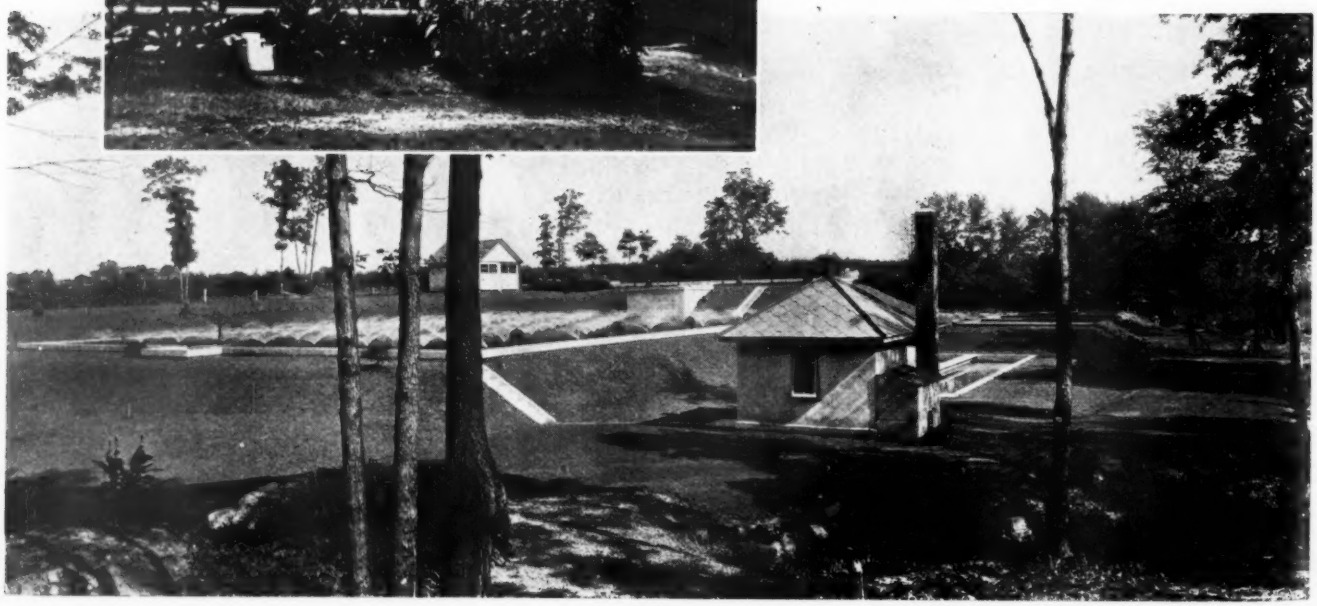
The plant is reached by a hard-rolled cinder road, kept free from grass and weeds. Signs notify visitors that they are welcome. Smooth trimmed lawns surround the plant units, which are connected by concrete walks and steps. Cannas, zinnias and marigolds are grown in the flower beds, and groups of dahlias, rose bushes and evergreens have been carefully placed to set off the various units most advantageously. The influent pipe, which is elevated about 2 ft. above the ground, is hidden from view by rambling roses. The near-by wood has been cleared of underbrush, and marshy spots have been drained and filled in. Close attention is given to the tank and filter to prevent any trouble that would detract from the pleasant impression given by the plant.

The Glassboro plant was designed by Remington, Vosbury & Goff, of Camden, N. J., with William Goff in complete charge of the installation. Operation of the plant is under the supervision of C. H. Shute, superintendent of sewage disposal.

Large stones painted white mark the road leading to the Glassboro, N. J., sewage disposal plant

Left—The influent pipe is partly covered with flowers

Below—View of plant, showing chlorine house, final settling basins, filter bed, dosing tank, Imhoff tank, sludge-drying beds and garage



FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor
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Bacterial Aftergrowths in Water Distribution Systems

A NUMBER of water works have at times been troubled with bacterial increases in the water after it leaves the purification works. Sometimes the increase has been so great as to create doubt as to the safety of the water. Health officials have in some instances become very much concerned about the conditions of the water and have insisted on the chlorine being increased, frequently to the point where it gives the water a disagreeable chlorine taste. Even this has not altogether prevented the aftergrowths. It is the desire of every water works official to furnish water that is safe for human consumption at all times, and at the same time he wants to furnish water that is palatable. It is the purpose of this article to give some information on the causes of bacterial aftergrowths and to suggest remedies.

During 1929 the Committee on Water Supply of the Public Health Engineering Section of the American Public Health Association collected data from a number of cities throughout the United States on bacterial aftergrowths in water distribution systems. The report of this committee was published in the May, 1930, issue of the *American Journal of Public Health*. The worst conditions as found by the committee were in cities either not filtering their water, or in cities having open reservoirs connected with the distribution system beyond the point where the water is treated. The writer has been able to collect some additional data on the subject that might be of value.

Why Progress Has Been Slow.—Probably the main reason why little progress has been made in preventing bacterial aftergrowths is that the cause has not been determined in most instances. In fact in most instances those who are aware of such troubles have made little effort to prevent the aftergrowths, though there are a few who have increased the chlorine dosage over what is necessary to make the water test safely shortly after the application of the chlorine, hoping to lessen the aftergrowths. The writer will give his experience with aftergrowths, hoping it will stimulate others to study their conditions and to apply remedies.

While operating a small filtration plant in 1915 and 1916, bacteriological samples were collected weekly at several points on the distribution system of the city remote from the filtration plant. The sampling points were on what are commonly called "dead ends." In most instances the samples did not show results greatly different from those at the filtration plant. There were times, however, when both the counts and the B. coli were considerably higher than at the plant. The writer collected the samples—the procedure being to open a fire hydrant, let the water run for about one minute at a rate of perhaps 15 to 20 gal. per minute, collect the sample, and then flush the "dead end" by opening the hydrant wide for 5 to 10 minutes. The flushing kept the "dead ends" in fairly good condition, except for an occasional increase in the bacteria.

Experiences at Baltimore, Md.—The writer's next experience with bacterial aftergrowths in a water distribution system was at Baltimore. Samples were collected daily for several years from the laboratory tap at the filtration plant. This was water that had passed through several miles of the distribution system before returning to the filtration plant through the distribution mains. After leaving the filtration plant the water flowed first through a tunnel, and then large pipes to a pumping station about 2 miles away, where part of it was pumped into the section of the city where the filtration plant was located. The hydraulic grade line to the pumping station was considerably above the ground line, so there could be no possibility of ground water pollution. At that time the pumps did not run continuously. While they were running the excess water over the consumption went into a balancing reservoir of about 37 million gallons capacity, and when the pumps were off the water flowed from the reservoir back into the distribution system.

There was no way of telling whether the water from the laboratory faucets was direct from the pumps or from the reservoir. Very likely it came from both sources. The laboratory faucet samples were collected daily, except Sundays, until a booster pump was installed at the filtration plant. After this, the laboratory faucet water was largely water direct from the filters. During the warmer months of the several years in which the samples were collected there was considerable increase in both the bacterial counts and the number of B. coli. The increase was more pronounced in some years than others, but there was always some increase each summer. One month in which there was not a single 10-cc. tube showing the presence of B. coli out of about 250 tubes in the water leaving the filtration plant, the laboratory faucet water showed 68 per cent of the 10-cc. tubes positive.

The portion of the city served by this pumping station and reservoir was largely residential, and so far as was known there were no cross connections with private supplies. The reservoir was open and the sides were lined with stone riprap. The water in the reservoir always stood above that of the surrounding ground, and any leakage would have been from the reservoir and not into it. The danger of pollution from the air was not great. It was known that microörganisms, such as algae, protozoa and rotifiers grew abundantly in the reservoir at times, but no systematic tests for such organisms were made. The writer came to the conclusion that the growths in the reservoir furnished the food for the bacterial growths. Several attempts to

determine if B. coli would increase in water containing microörganisms did not produce information of much value at that time.

Growth of B. Coli on Decaying Microörganisms.—It is only recently that evidence which appears to be fairly conclusive has been obtained on the growth of B. coli on decaying microörganisms. Raw water which received no treatment except to be chlorinated was passed through a closed glass tank at a fairly slow velocity. The water contained residual chlorine all the time, averaging about 0.2 part per million. The raw water contained an abundance of microörganisms, largely diatoms, which settled out quite readily and soon formed considerable deposit at the bottom of the tank. Tabellaria predominated in the sediment, but there were some melosira, synedra, asterionella, fragilaria, and a few other species of algae. There also were a few protozoa, rotifers, crustacea, etc., but about 99 per cent of the volume of the organisms present in the sediment were diatoms. With this water going into the pipes we should expect the same deposit of microörganisms to take place in the pipes at points where the flow is slow.

Part of the sediment in the tank was withdrawn with sterile pipettes and placed into chlorine-free sterile water. Examining with a microscope revealed a number of protozoa of an undetermined specie feeding on the vegetable matter. It is evident that algae cannot live in water containing so much residual chlorine, and it is likely that they were all dead before being deposited in the tank. Protozoa of the type found in the sediment probably could not live in water containing residual chlorine. It is likely that after the sediment became a certain thickness the residual chlorine did not penetrate through it and there was a zone of chlorine-free sediment.

Measured portions of the sediment were placed in broth tubes and in sterile water. The sediment after being removed from the tank was very soft and probably was at least 95 per cent water. About 75 per cent of the solid portion was composed of microörganisms. The counts were on agar plates, and the test for B. coli was in accordance with the usual procedure. In a few tests here it was known that all the bacteria present were B. coli, the counts were made on agar plates.

Table I.—Bacteria in Sediment Largely Composed of Dead Diatoms

Sample	Bacteria Per CC. 37°	Bacteria Per CC. 20°	B. Coli Per 100 CC. Presumptive	B. Coli Per 100 CC. Final	Per Cent of Tubes Showing Gas Which Are Postive to Methyl Red and Negative to Voges Proskauer
1	1,000,000	.....	16,000	175	60
2	575,000	3,900,000	17,500	300	33
3	465,000	.....	4,300	2,440	88

Table II—Increase in B. Coli When Plain Water and Water Containing Sterile Sediment Is Inoculated with B. Coli

Days Standing	Inoculated with B. Coli that Are Negative Both to Methyl Red and to Voges-Proskauer: 400 CC. of Sterile Raw Water	Inoculated with B. Coli that Are Negative Both to Methyl Red and to Voges-Proskauer: 400 CC. of Sterle Water with 30 CC. of Sterile Sediment	Inoculated with B. Coli that Are Negative to Methyl Red and Positive to Voges-Proskauer: 400 CC. of Sterile Raw Water	Inoculated with B. Coli that Are Negative to Methyl Red and Positive to Voges-Proskauer: 400 CC. of Sterle Water with 30 CC. of Sterile Sediment
0	540,000	240,000	23,400	18,000
1	1,245,000	13,800,000	58,000	4,250,000
2	1,750,000	41,000,000	900,000	11,750,000
4	1,570,000	28,250,000	400,000	17,750,000
6	1,835,000	28,800,000	.....	17,750,000
*6	2,500,000	25,000,000	350,000	16,000,000
12	1,850,000	32,500,000	2,235,000	20,775,000

*Number of B. coli estimated from broth tubes.

When broth tubes were used the McCrady system of determining the number of B. coli was used. Table I gives the results of 3 series of tests. For sample 1, the 10-cc. and 1-cc. portions of the sediment were measured direct, but diluted for lower quantities. Samples 2 and 3 were diluted before being inoculated, but the results are expressed in terms of the volume of the original sediment. The large number of B. coli that were positive to methyl red and negative to Voges Proskauer indicate that B. coli which are thought to be of fecal origin will grow on decaying microörganisms.

Determination of Growth on Sediment.—To determine if B. coli will grow in the laboratory on sediment composed largely of dead microörganisms, two 30-cc. portions of the sediment from the glass tank were sterilized in an autoclave and added to 400 cc. each of sterile water. To another 400-cc. portion of sterile water, 30 cc. of the sediment without sterilzation was added. The two flasks containing the sterile sediment were inoculated with B. coli taken from pure culture on agar slants. As soon as the B. coli were thoroughly mixed in the solution, samples were taken and plated on agar. The flasks were then stored in the 20° incubator. In addition to this, two 400-cc. portions of sterile raw water which contained a few diatoms were inoculated with B. coli from the same agar slants. These two samples are compared with the two containing 30-cc. portions of the sterile sediment in Table II. Table III shows both the count and the B. coli for sterile water inoculated with 30 cc. of the sediment from the tank which was not sterilized.

It is interesting to note a material increase in the B. coli when inoculated in plain sterile raw water. It is possible that enough of the media from the agar slant may have been transferred to the flasks in making the inoculation to give some food for the B. coli growth. It also is possible that the dead microörganisms, which probably averaged about 100 cubic standard units, were sufficient to produce or help produce the increase. At any rate the B. coli increased in the sterile raw water on standing whereas it was expected that they would decrease. The significant fact from the results shown in Table II is that the B. coli increased in the water containing the sediment to a very much greater extent than in the plain water and gives proof that the sediment at least furnished part of the food for the growth. Heating the sediment to sterilize it may have brought about changes in some of the organic compounds and this may have been partially responsible for such a great increase.

The growth of B. coli on dead microörganisms appears to be contrary to what is found naturally in most instances, but it may be that the reason why B. coli do not increase under such conditions as that they are prevented from growing by other organisms. It will be noted from Table III that the B. coli did not increase in the sample in which the added sediment was not sterilized. The water in this flash soon developed a very offensive odor of decomposition resembling that of the sludge in a sewage disposal plant. The general trend of the figures are downward on standing, and this perhaps is analogous to what takes place naturally in lakes and reservoirs.

There are a few types of organisms that grow in the dark, and where this is the case there may be times in which part of them die and furnish food for bacterial growths. The writer recalls while at Baltimore, the filtered water reservoir underneath the filters was drained for a few days. The water was not chlorinated on this reservoir. The sidewalls had a dark coating, largely manganese. Within this coating were micro-

scopical growths. Quite a large number of nematodes were found in the microscopical growths. After standing two or three days exposed to the air the odor of decomposition was very offensive throughout the reservoir. Microörganisms that do not live in the dark, when carried into the distribution system die and furnish food for bacterial growths, unless the water contains residual chlorine all the time. In cities like New York, Chicago, and Boston, where the water is not filtered, and where microörganisms are likely to be carried into the distribution system, it seems reasonable to expect occasional bacterial aftergrowths in any section of the city where residual chlorine is not maintained in the water. Any city having an open reservoir in which microörganisms are allowed to grow may have aftergrowths in the section supplied by the reservoir.

Bacterial Growth in Pipe Sediment.—To prove more conclusively that B. coli and other bacteria will grow in the sediment which accumulates in water pipes where the water contains microörganisms, another series of tests were run in which water containing microörganisms was allowed to flow from a faucet at the rate of about 200 cc. per minute. The water had been treated with about 0.5 part per million of chlorine, and that coming from the faucet at the slow rate of flow always contained residual chlorine. The residual ranged from 0.1 to 0.3 parts per million. This slow rate of flow was a pick-up of the sediment which had settled in the ¾ in. pipe leading to the faucet. It is believed that most of the microörganisms were killed by the chlorine. When the faucet was turned on nearly full force there was a pick-up of the sediment which had settled in the pipe, and the water would come out fairly turbid for a short period after increasing the rate. The sediment contained an abundance of microörganisms, most of which were diatoms. There were a few crustacea present, such as cyclops, bosmina and daphnia.

The procedure for testing was to collect a sample of the water in a sterile bottle for bacteriological tests while the flow was slow, also a sample for making a residual chlorine tests. About 10 cc. of sterile lactose broth, the same used for B. coli tests, were placed in another sterile sample bottle just before collecting the sample at the rapid flow. The faucet was then opened so that the flow would be rapid enough to pick up the sediment in the pipe, and the sample collected when the residual chlorine test. About 10 cc. of sterile lactose broth was to use up the residual chlorine immediately so there would be no danger of the bacteria in the sediment being killed. The plates and broth tubes were inoculated within a few minutes afterwards, and the broth placed in the sample bottle could not affect the number of bacteria. The results of the tests are given in Table IV.

It is evident that bacterial growths in water distribution systems are dependent upon the water containing food for the growths, and upon it being free from sterilizing agents such as chlorine. Water containing organic matter that settles or attaches itself to the side of the pipes may produce a coating so thick that even though the water contains considerable residual chlorine there will be a zone of chlorine-free water within the coating or within the sediment where bacteria may grow abundantly. Where the residual chlorine does not extend throughout the distribution system, as is the case for many water supplies not heavily chlorinated, there may be danger of bacteria increasing within the water if it remains in the distribution system for several days such as may be the case in some "dead ends."

About 12 or 13 years ago the writer conducted a series of experiments in which filtered water of fairly low organic content was stored in pyrex flasks in a 20 degree incubator. The flasks were cleansed very thoroughly. The oxygen consumed test on the water which was used was approximately one part per million, which is fairly low when compared with many water supplies. The water had been chlorinated, and the bacteria averaged less than 10 per cubic centimeter. The bacterial counts in the stored water remained low for about 48 hours, then they increased rapidly. After a period of from two to three weeks the counts were in excess of one million bacteria per cubic centimeter in most of the samples. The counts then gradually decreased. There was no increase in B. coli in any of the samples. This indicates that it is impossible to keep the filtered water from many supplies in the dark for several days without danger of aftergrowths, though there does not seem to be much danger of B. coli growing except in the presence of considerable organic matter such as decaying microörganisms, etc. Even then other bacteria grow so readily they usually prevent the B. coli from increasing

Table III—Growth of Bacteria in Water Containing Dead Microörganisms

30 cc. of sediment from glass tank added to 400 cc. of sterile water. Sediment not sterilized.

Days Standing	Bacteria Per CC. 37°	Bacteria Per CC. 20°	B. Coli Per 100 CC. Presumptive	B. Coli Per 100 CC. Final	Per Cent of Tubes Showing Gas Which Are Postive to Methyl Red and Negative to Voges-Proskauer
0	32,500	1,515,000	300	170	88
1	63,000	1,200,000	....	....	....
2	329,000	700,000	1,600	25	86
4	.....	.....	80	4	50
6	.....	.....	50	8	50
12	1,000	113,000	350	14	100

Table IV—Bacterial Content of Water from a Faucet Running Slow and Running Fast So as to Pick Up Sediment from the Pipe

Time Running at Slow Rate Before Collecting Sample	Water Passing Faucet at Slow Rate of Flow: Bacteria Per CC. 37°	20°	B. Coli Per 100 CC.	Faucet Running Fast to Pick Up Sediment: Bacteria Per CC. 37°	20°	B. Coli Per 100 CC.
1	1	0	0	8,200		70
1	0		0	17,500		130
1	1		0	20		8
1	0	0	0	500	250	2
1	1	0	0	35	850	4
1	0	0	0	4,200	120,000	35
4	3	2	0	300,000	90,000	1,600
1	1	2	0	20,000	26,000	7
1	1	2	0	2,500	3,000	11
1	1	1	0	1,100	12,500	8
2	0	3	0	12,500	90,000	1,800
1	2	1	0	4,100	19,500	0
1	0	1	0	40,000	74,000	50
4	1	0	0	35,000	45,000	13
2	0	0	0	70,000	48,000	4
1	0	0	0	4,200	4,800	2
2	1	0	0	4,250	4,000	0
1	0	0	0	40	250	0
1	0	0	0	5,300	5,500	0
1	1	1	0	12,500	16,500	5
1	0	1	0	1,800	2,000	5
5	1	1	0	8,400	22,000	8
1	1	1	0	700	550	25
1	1	4	0	100	90	7
1	2	2	0	160	200	8
2	0		0	210	325	2
1	0	0	0	10,000	11,000	25
1	1	1	0	130	180	50
1	1	1	0	220	180	2
1	1	2	0	4,000	11,500	40
3	0	2	0	250	7,500	11
3	2	1	0	30	11,000	2
1	6	8	0	75	55	5
1	20	20	0	20	250	2
1	25	14	0	180	180	0

materially. Either this is the case, or a special kind of food is required for B. coli growths. Fortunately the water does not remain long in the distribution pipes of some supplies, or the water would show a material increase in bacteria in passing through the distribution system. This increase is without sanitary significance except that should the water happen to become polluted the pollution might be attributed to natural increases and a dangerous situation might be ignored.

How to Avoid Bacterial Aftergrowths.—To avoid bacterial aftergrowths the water should be free from suspended organic matter or any matter that will form a gelatinous coating on the pipes such as manganese and iron, also it should be low in organic compounds that support bacterial growths. When it is not possible to produce water low in organic content the water should contain residual chlorine throughout the entire distribution system if an increase in the bacteria is to be avoided. It is easy to remove microörganisms and other suspended particles by filtration, but it is not easy to reduce the organic content of many waters to the point where it will not support bacterial growths.

No open reservoir should be connected to the distribution system of any water supply unless the water in the reservoir contains sufficient chlorine or other sterilizing agent to prevent biological growths all the time. Chlorinating the water leaving the reservoir may make it safe bacterially, but does not prevent microscopical growths that may later be food for bacterial growths in the distribution system. It was shown by Table IV that microörganisms depositing in the pipes may cause bacteria to grow abudantly even though the surrounding water has an excess of chlorine. Most of the troubles from bacterial aftergrowths in present water supplies may be avoided by the elimination of open reservoirs and the filtration of such supplies as are not now filtered.

Designing engineers should not under any ordinary circumstance recommend open reservoirs on a water distribution system. Confine the storage capacity to reservoirs that can be covered, and provide the desired fire protection by having sufficient storage capacity prior to filtration. With ample filtration capacity and sufficient duplication of pumping units excellent fire protection can be provided with a storage capacity of about 24 hours in balancing reservoirs. It would not be a burden on any city to cover such size reservoirs. Chicago, and a number of other cities have no elevated storage, yet they have excellent protection against fire.

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Water Works in Flood Areas

A paper on disaster preparedness plans for water works presented at the St. Louis Convention of the American Water Works Association by George W. Pracy, Superintendent City Distribution Division of the San Francisco Water Department, brought out much interesting discussion. An abstract of the paper is printed in this issue. Among the discussions was a contribution by J. H. O'Neill, Chief Engineer, Louisiana State Board of Health. This is reprinted below from the September Journal of the American Water Works Association.

One very important difference between earthquakes and floods, as we know them in the Mississippi Valley at least, is that we usually have warning of flood levels some time in advance and thus have time to prepare for the emergency. There are, of course, places where dangerous floods have occurred with as little warning as in the case of earthquakes. However, much of this discussion is applicable to plants wherever they may be located.

The problem may be considered from three viewpoints: location of plant, construction, and maintenance under disaster conditions. The line between these, of course, may not always be sharply drawn.

Even in the low areas subject to floods in the valley, there is sometimes a choice as to plant location. If possible, the plant should be located above the elevation of maximum flood level. In 1927, a certain motor driven power and pumping plant built to replace an old steam plant, and at a lower elevation, was flooded, while the reservoir, treatment plant and abandoned steam plant were unaffected. It would have been possible at a slight additional cost to build the new plant at the higher elevation.

If at an elevation subject to flood the plant may be protected by levees or in some places by closing door and window openings to the required height by brick or concrete walls. One important detail is to see that exhaust pits, or mufflers, for internal combustion engines are protected against flooding either by levee, wall or by elevation. The plant above referred to operated for some time with 3 ft. of water against the walls of the building, but failed when water entered the exhaust muffler pits.

Even with plants which do not normally use chlorine, provision should be made in advance so that chlorinating equipment may be installed quickly, and chlorine applied at one or more points in an emergency. State Boards of Health usually have portable chlorinators available. Manufacturers of such equipment are generous in furnishing equipment and personnel in disasters. Care should be taken to avoid overdosing with chlorine, since objectionable tastes and odors due to overdosing may lead people to use water from other sources which may be unsafe. Control of chlorine dosage by the orthotolidin test is simple and of great value. Material for this test can usually be obtained from the State Board of Health. Chloride of lime or hypochlorite solutions are usually obtainable from drug stores or laundries and may be used pending delivery of chlorine and chlorinating equipment. Plants using lime for softening can sterilize the water by overdosing to a caustic alkalinity.

Auxiliary sources of power should be provided, either by gasoline engines or supplementary power lines from other plants. The rapid development of "high lines" tying together power plants scattered over a wide area is helpful in this respect. Emergency equipment should include provision for removing seepage, waste waters, and wash water from filters. Motor driven fire engine equipment may be useful in an emergency and any necessary couplings for such use should be obtained and held as a part of reserve equipment.

Fire hydrants should be marked by flags to make them easy to find and to minimize possible breakage by boats. Red lanterns may be used at night if boat traffic in flooded streets is heavy.

Generous use of valves in a distribution system, so that sections with breaks may be isolated, is worth while in any system, but is particularly important in systems in areas likely to be affected by disasters.

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JOINT COMMISSION TO END POLLUTION OF WATERWAYS.—Steps have been taken toward the creation of a commission to represent New York, New Jersey and Connecticut in formulating a treaty between the three states and the Federal Government to end the pollution of waterways.

New Activated Sludge Treatment Plant for the City of Woonsocket, R. I.

Several Novel Features Have Been Incorporated in the Design of This Plant, Construction of Which Was Started on July 5, 1930; It Is Anticipated That the Plant Will Be Completed and Placed in Operation by March 1, 1931

By PHILIP B. STREANDER

Associate Engineer, Remington, Vosbury & Goff, Consulting Engineers, Camden, N. J.

THE city of Woonsocket, R. I., has now under construction a sewage treatment plant of the activated sludge type, the effluent of which will be chlorinated and discharged to slow sand filters. Several novel features have been incorporated in the design of this plant which are worthy of description.

Woonsocket is situated on the Blackstone River in the extreme northerly part of the state. The river has quite an extensive watershed and flows in a circuitous course through the city, combining with several smaller streams to form the Seehonk River, which flows through and divides the city of Providence from Pawtucket and East Providence and empties into Narragansett Bay. The condition of the stream is naturally governed by seasonal variations in precipitation and temperature. During the summer months the dissolved oxygen saturation above the city averages about 70 percent. This is rapidly lowered in flowing through the city and zero saturations have been noted a distance of not more than a mile below the city. The reduction is caused almost entirely by the discharge of raw and partly treated sewage from an existing treatment plant and the discharge of a considerable volume of trade wastes.

The city has a total population of about 50,000 and is a typical industrial city, having some 87 industries employing about 15,000 workers. The industries are varied but consist principally of woolen and textile mills with their allied products. At the present time most of the wastes produced by the various industrial establishments are discharged directly into the Blackstone River, with little or no treatment. Upon completion of the sewage treatment plant, these wastes will be discharged into the city sewer system.

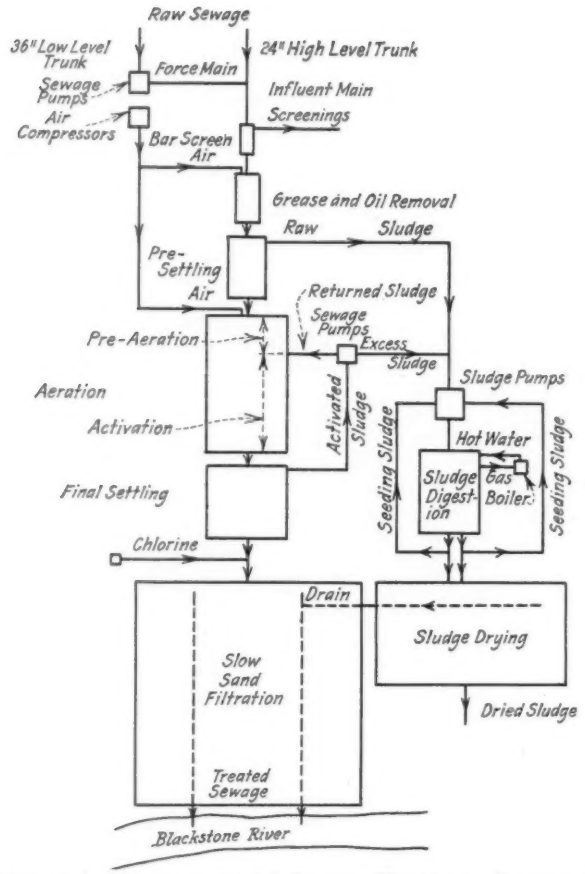
The city has a separate sewer system, consisting of about 55 miles of sewers ranging in diameter from 8 to 36 in., with a treatment plant situated in about the geographical center of the city. This plant was constructed in 1896 according to plans prepared by the late Rudolph Hering. The original plans called for two storage basins, a pumping plant and 5 acres of slow sand filters. For a population of about one-half of that now obtaining, it amply served the purpose. Later, additional sand filter beds were added, bringing the area up to a total of 10 acres, With a rapid growth in population and industrial extension the plant became utterly inadequate to treat the sewage reaching it, of necessity a part of the raw sewage was by-passed directly to the river and only that part of the total requiring pumping was discharged to the slow sand filter beds. The discharge of the raw and partly treated sewage and trade wastes directly into the river gave rise to gross pollution. During the summer months the dissolved oxygen content was reduced to a point sufficient to give rise to objectionable odors and caused a general nuisance to sight and smell. The condition necessitated the construction of a plant capable of meeting present-day demands.

As a result of various studies made, the conclusion was reached that the activated sludge process followed by sand filtration was the most economical and would best meet the conditions obtaining for this particular installation. One decided factor having considerable influence on this choice was the location of the plant. Being almost in the geographical center of the city, any plant constructed must of necessity be comparatively free from local and migratory odors. Another factor was the small loss of head required, causing a saving in pumping costs and in addition allowing for gravity flow of sewage to the plant from a comparatively large area of the city. Any other method would have, of necessity, required pumping.

Pumping Station Electrification.—In addition to the construction of the treatment plant, the existing pumping station will be equipped with electrically-operated sewage pumps and the station reconstructed into an administration building for housing the air compressor units and the testing laboratory. The pumps will be of the vertical motor-operated type, placed in a dry well and provided with non-clogging impellers. To meet the varying rate of flow in the sewer the pumping units will be of the variable-speed type, with automatic control equipment so designed as to pump sewage at approximately the same rate as the rate of sewage inflow to the station. Equipment of this type undoubtedly increases the average efficiency of the treatment process, as the discharge from the pumps is free from surges and irregularities and rates between minimum and maximum are effected gradually with no sudden fluctuations. The control equipment will automatically vary the speed of one or two units so as to obtain a varying rate of pumping between a minimum of 400 and a maximum of 4,200 g. p. m. A venturi meter is provided to indicate and record the volumes of sewage pumped and a depth gauge to indicate and record pump suction-well level variations.

Sewage pumped and that reaching the plant by gravity will combine in a junction manhole and will then flow through a mechanically-cleaned bar screen and a metering chamber in which an indicating, recording and totalizing gauge is provided to measure all of the flow reaching the plant.

Skimming Tank.—To remove most of the animal, vegetable and mineral oils present in a sewage of the character encountered, there has been provided an aerated skimming tank. This tank is provided with a central chamber in which are placed suspended air diffusers to agitate the sewage violently and cause it to flow over baffles into collecting and return chambers on each side. These chambers are provided with sloping bottoms connected to the central air chamber. The minute air bubbles and the agitation provided cause



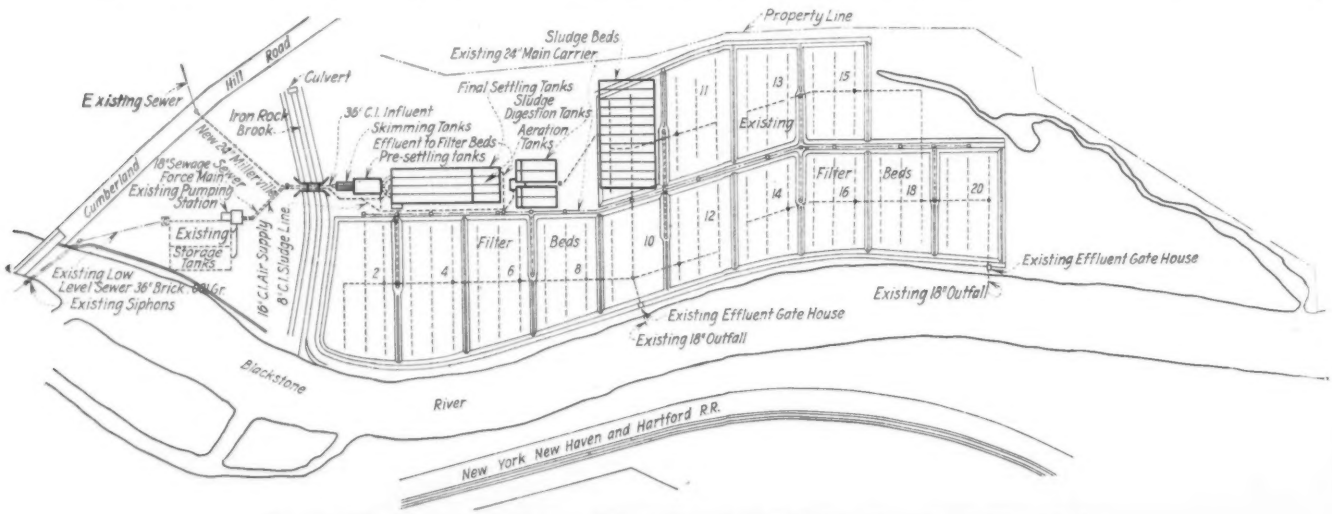
Diagramatic Arrangement of Sewage Treatment Process for Woonsocket, R. I.

partial saponification of the oils and greases. The mixture of air and saponified oil and grease, being lighter then the sewage, floats to opposite sides of the collecting and return chamber from which it will be skimmed into troughs. At normal flow the detention period is about 6 minutes.

Primary Settling Tank.—From the skimming tank the sewage is discharged into a primary settling tank designed to provide a detention period of 1 hour. Submerged tapered inlets are provided, discharging against a slotted baffle wall to distribute the sewage into the tank. The tank is divided into two separate compartments, each provided with mechanically-operated scrapers to remove the settled sludge, which is concentrated in storage hoppers and removed by means of a sludge pipe, operating under a hydrostatic head of 4 ft. Perforated piping is provided in the hoppers so that they can be periodically flushed down. Floating scum which may accumulate on the surface of the tank is removed by the return of the scrapers and concentrated at a scum trough located at the effluent end of the tank and so arranged that any floating solids can be easily skimmed off. The settled sewage discharges into a common flume in which there are provided four V-notch weirs which act as distributors and balancers to the aeration tank compartments. Means have been provided so that any predetermined volume of excess activated sludge can be returned directly to the influent end of the tank to assist in settling out the solids in the raw sewage and further to condition the sewage, a feature quite valuable where indstrial wastes enter the plant.

Aeration Tanks.—A somewhat unusual method of aeration has been provided in the aerating tanks. This consists of an "air-lift" changed having a width of 2 ft. constructed at one side of each compartment, in which there are located submerged air diffusers. The air diffusers consist of two 3-in. inside diameter porous refractory tubes, placed on 12-in. centers, 4 ft. below the surface of the sewage. The lower end of the air-lift channel extends to within 2 ft. of the bottom of the tank and sewage is forced upward through this opening by the heavier volume of sewage outside of the air-lift channel. The discharge end of the air-lift channel is provided with a throat arranged so that the mixture of air and sewage will flow rapidly across the surface of the aerating compartment. The aerating compartment is provided with deflectors at each turn to reduce friction and effect easy changes in direction of flow. It is estimated that the volume of air required to obtain a transverse tank velocity of 1.5 f.p.s. is 2.0 c.f.m. per lin. ft. of tank.

The tank is designed to provide an areation period of 6 hours with 25 per cent returned sludge and is divided into four separate compartments, each having a sewage depth of 12 ft., a width of 18 ft. and a length of 180 ft. By reason of the air-lift chamber it is essentially of the spiral-flow type. Compressed air, as previously stated, is introduced into the air-lift channel in each compartment through porous tubes placed 4 ft. below the surface of the sewage. The air is discharged into so-called units, each unit consisting of two 2-ft long porous tubes separated by means of an air-inlet casting, with the ends sealed by end caps and the assembly held together by means of a through bolt. One air-pipe connection is provided for two units, with a stop

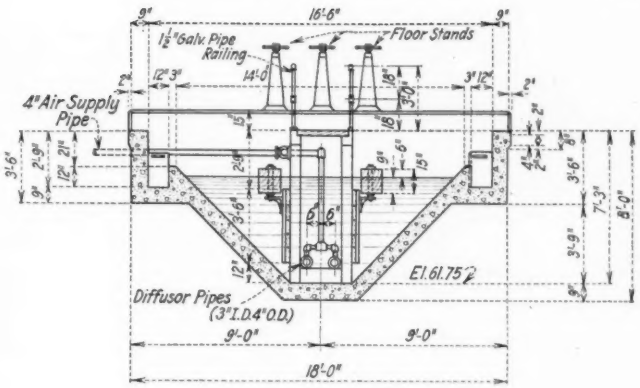


General Plot Plan of Treatment Plant, Showing Eixisting Slow-Sand Filter Bed

cock to regulate the volume of air or to cut the two units out of service so that they can be removed and cleaned. Two air manifolds are provided, one for each two compartments, and they are in turn centrally manifolded to secure even distribution of air to each lateral manifold.

The aeration tank is so designed that the point of applying the returned activated sludge can be readily varied. The tank volume preceding the application of the sludge will be used for pre-aeration of the sewage without any sludge. The object of this pre-aeration is to freshen up the sewage by driving off such toxic gases as the sewage may contain, which gases are deleterious to the delicate organisms which constitute the return sludge. Experience has demonstrated that comparatively short periods of pre-aeration without the return of activated sludge have reduced the biochemical oxygen demand by as much as 30 to 40 per cent. Each compartment is provided with four wood diaphragm walls to prevent short circuiting of the chore of the tank. In passing through the tank the sewage between the diaphragm walls must flow over or under these diaphragms.

As previously stated the volume of air required to secure non-settling velocities is about 2.0 c.f.m. per lin. ft. of tank. There being, all told, four compartments each 180 ft. long, or 720 lin. ft. of tank, the minimum air requirement for circulation is about 1,500 c.f.m. This is equivalent to about 0.70 cu. ft. of air per gal. of sewage. The sewage reaching the plant is somewhat stale and has an average suspended solid content of about 225 p.p.m., a free ammonia content of about 30 p.p.m., a chlorine content of about 72 p.p.m. and consumed oxygen 73 p.p.m. The foregoing are averages and are subject to considerable fluctuation. After completion of the treatment plant, the trade-waste flow will be considerably augmented by additional wastes from industries now discharging into the river. This will undoubtedly change the characteristics of the sewage and non-settling tank velocities will not be the determining factor in air requirements. Undoubtedly a considerably higher velocity of rotation will be required to expose the sewage to atmospheric contact for the absorption of oxygen. Sufficient air compressor



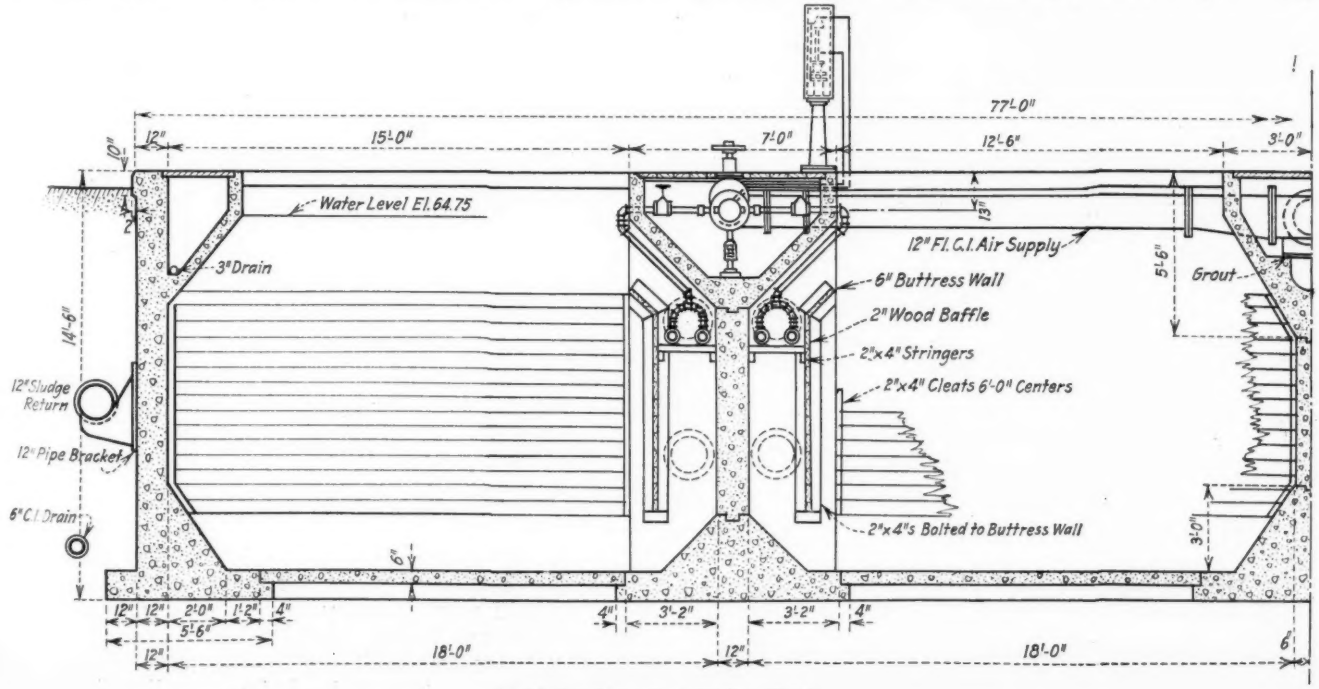
Section of Skimming Tank

capacity was provided to secure a maximum tank velocity of 4 to 5 f.p.s., requiring about 5.0 c.f.m. of air per lin. ft. of tank or a total of 3,600 c.f.m., this being equivalent to a maximum of 1.70 cu. ft. of air per gal. of sewage.

Air Compressor Plant.—The compressors are to be installed in what was the boiler room of the existing pumping station and will be in duplicate. They are of the high-speed single-stage type, developing a pressure of 3.0 lb. at 60 deg. F. Each compressor has a capacity at this pressure of 4,200 c.f.m. and is operated by an 85-hp. motor. Between 200 and 300 c.f.m. of air will be used in the aerated skimming tank, the remainder being available for the aeration tank. The pressure curves of these compressors are somewhat flat from the maximum capacity to the dropping-off point; therefore the power inputs between the two points give almost a straight line. The input to the motors in kilowatts for various capacities is as follows:

4,400 c.f.m.	76 kw. input
3,600 c.f.m.	63 kw. input
2,800 c.f.m.	50 kw. input
2,000 c.f.m.	37 kw. input

It is considered probable that the actual air requirement for the aeration tank will be about 2,800 c.f.m., requiring 50 kw. power input. This is equivalent to about 15 kw. per m. g. of sewage, which at prevailing



Half Section of Aeration Tank

power rates of about 1.45 ct. per kw.-hr. is equal to $5.65 per m. g. of sewage.

All air is filtered on the suction side of the compressors, for removing any dust or foreign matter contained in the air. The compressor discharge is passed through a venturi meter having an indicating, recording and totalizing register.

Final Settling Tank.—Aerated sewage discharges over a baffled weir into the final settling tank. This tank is divided into four separate compartments, each 18 ft. wide and 60 ft. long, and has an average depth below the sewage level of 9 ft. It provides a detention of about 2 hours at the nominal capacity. Settled sludge will be removed by mechanically-operated scrapers, concentrating the sludge in steep-angle hoppers located at the influent end of each compartment. These hoppers are provided with perforated water-flushing piping set around each hopper for periodic flushing.

Sludge is removed from each of the hoppers by means of a vertical sludge pipe, extending from the bottom of the hopper to a sludge withdrawal chamber, the bottom of which is 12 in. below the sewage level. An adjustable sludge decanter is provided which slides inside of the sludge riser pipe. This decanter consists of a short length of 10-in. brass pipe, having a V-notch weir cut in the pipe. The pipe slides in a machined flange bolted to the sludge riser pipe and the top is capped for attachment of a threaded stem operated by a floor stand. This decanter can be raised or lowered depending on the amount of sludge it is required to withdraw. A sludge channel is provided on each side of the sludge withdrawal chamber over each sludge hopper. One of the channels is used to return activated sludge to the aeration tank and the other channel to return sludge to the pre-settling tank, or, in case poor sludge develops, it can be discharged directly to the main sludge drain pipe.

Activated Sludge Return.—Activated sludge from the final settling tanks is piped to a sludge-return pump house alongside the aeration tank, from which it is pumped to each compartment of the aeration tank. The sludge pumps are of the vertical motor-operated type, operating at a low speed. Manually-operated variable speed control is provided so that the capacity of the pump can be regulated to suit the volume of sludge reaching the pumps. The discharge is manifolded to the sludge return pipes, one to each aerating compartment, and venturi tubes are provided in each connection having air-driven indicating manometers, so that the volume return to each compartment can be measured and regulated. A valved connection is provided for the discharge of excess activated sludge to the main sludge drain leading to the digestion tanks.

Final Treatment.—An effluent main is extended from the final settling tank to a main carrier pipe feeding the 14 slow sand filter beds. Chlorine solution is applied in the effluent main for sterilization, prior to the application of the tank effluent to the beds. Pre-chlorination will undoubtedly accomplish the dual purpose of bacterial destruction and the maintenance of the beds in a clean, fresh condition.

The purification effected by the slow sand filters will practically consist of additional nitrification and the straining out of the small non-settleable floc carried over from the final settling tank. The improvement to the tank effluent will, of course, depend almost entirely on the degree of purification previously effected. With a rate of application of between 300,000 and 400,000 gal. per acre per day, the beds will undoubtedly be of considerable value as final treatment, particularly during the summer months.

Sludge Treatment and Disposal.—All sludge developed in primary and secondary treatment will be disposed of by digestion in separate sludge digestion tanks. These tanks are of the high-temperature type provided with facilities for the collection and burning of the gas under gas-fired boilers, which with the heating coils maintain the sludge as its optimum digestion temperature.

Two separate units are provided, each divided into three separate compartments, each compartment being 15 ft. deep, 15 ft. wide and 90 ft. long. The sludge will be maintained at the level of the underside of the roof, to hold scum in a moist condition and prevent the formation of a hard scum layer. Mechanically-operated scrapers are provided in each compartment, with scrapers arranged to scrape the bottom and the underside of the roof, extending to within 30 ft. of the effluent end of the tank at the bottom and 15 ft. at the top. These scrapers will concentrate all loose scum at the inlet end of the tank, where it can be flooded with fresh water spray, supernatant liquor, raw or digested sludge or any combination of these.

The influent end of each compartment is provided with an elevated portion designed to act as an equalizer in the filling and drawing of sludge and also for the accumulation and removal of gas. Super- or subnatant liquor will be removed through an adjustable decanter consisting of a screw, on which a nut supporting an entrance casting is mounted. This is connected to telescoping pipe and and an outlet casting extended to an inspection manhole. The decanter is operated by means of a gas-sealed indicating floor stand mounted on the roof of the tank. Digested sludge is withdrawn from the effluent end of the tank through a valved outlet connected to an inspection chamber. From this it is piped to a manifold chamber arranged so that the sludge can be either discharged to the sludge drying beds or returned for seeding of the raw sludge. Supernatant liquor will be passed through this same chamber and handled likewise.

Gas generated during the digestion of the sludge is concentrated in the elevated portion of each compartment and is removed through a sealed outlet. From here it is piped to a condensation trap, gas meter, fire trap and to the boiler. A pressure relief tank is provided in the system for relieving pressure developed by an excess volume of gas. Each compartment is provided with heating coils, placed at the sides of the walls, above the center of the tank. Orifice-operated manometers and thermometers are provided for each compartment supply, so that the volume of hot water can be regulated for even distribution. The boiler is of the gas-fired hot-water type, having an A. G. A. rating of 3,600 sq. ft. equipped with the usual automatic heat control mechanism, etc. Motor-operated circulating pumps have been provided, having a capacity of about 6,000 g.p.h. Water meter, expansion tank, pressure relief valves, etc., have also been provided.

Raw sludge from the primary settling tank and excess activated sludge are piped to a pump sump from which the sludge will be pumped out and discharged into the compartments of the digestion tank. Digested sludge for seeding is piped to the same pump and mixed here with the raw sludge. To gauge the volumes flowing in, V-notch weirs are provided on each sludge line. A motor-operated dry feed machine is provided for feeding hydrated lime to the sludge for pH correction and sludge conditioning. Means are provided for draining sludge from any compartment to the pump sump, so that the sludge can be drained out or recirculated. A small building at one end of the two digestion-tank

units houses the heating apparatus, sludge pumps and dry feed machine.

Digested sludge from the digestion tank is piped to glass-covered sludge drying beds. These beds were constructed over one of the existing slow sand filters, using the existing sand and gravel for underdrainage. The bed is 240 ft. long and 125 ft. wide. It is divided into 12 separate beds, one-half of which are glass covered. The remainder of the bed is open, but walls and piers are provided so that the glass covers can be installed at a future date. Having open and glass-covered beds will afford an opportunity to demonstrate the advantages of glass covers in this section of the country.

A main narrow-gauge tank is provided to serve the beds, with switches and track for each bed. Rocker dump cars and a gasoline locomotive will be used to haul the sludge out of the beds. Dried sludge will be largely used by the city for conditioning its lawns and parks. Excess sludge will be used for the filling in of adjoining low land.

Cost of Construction and Operation.—The contract price for the construction of the treatment plant, the reconstruction and electrification of the pumping station, etc., is $360,000. The estimated cost of operation including power required for pumping the sewage, air compressors, sludge conveying and pumping equipment, chlorination, superintendence and labor required for the complete operation of the plan is $25,600.

Capacity of Plant.—The capacity of the plant was based on 1940 sewage flows from an estimated population of 60,000. The dry-weather rates of flow estimated from this population are as follows:

24-hour average flow	3.0 m.g.d.
12-hour-day rate of flow	3.9 m.g.d.
Peak hourly rate of flow	5.0 m.g.d.

During rainy weather these rates will be increased by additional ground and surface-water infiltration, as follows:

24-hour average flow	3.6 m.g.d.
12-hour-day rate of flow	4.5 m.g.d.
Peak hourly rate of flow	7.0 m.g.d.

The units of treatment were designed on the basis of 3.6 m.g.d., and on this basis the cost of construction per m.g. of capacity is approximately $100,000. The operating cost, based on an estimated 1935 daily flow of 2.5 m.g.d. of which 2.0 m.g.d. will be pumped, is $25.20 per m.g.

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Meter Reading and Billing at Hartford, Conn.

The following note is taken from the 1929 report of the Board of Water Commissioners of Hartford, Conn.:

The meter reading force consists of an assistant foreman and six readers. The territory is divided into 7 zones of which readings are taken every other month and billed semi-annually—the 7th zone comprising the larger meters, being read and billed monthly. Each reader averages about 90 meters daily.

Zone No. 1 is billed in Feb. and Aug.—Averages 3,574 meters
Zone No. 2 is billed in Apr. and Oct.—Averages 3,480 meters
Zone No. 3 is billed in June and Dec.—Averages 4,245 meters
Zone No. 4 is billed in Mar. and Sept.—Averages 3,868 meters
Zone No. 5 is billed in May and Nov.—Averages 4,302 meters
Zone No. 6 is billed in Jan. and July—Averages 3,089 meters

Each zone is placed in the mail the last day of the month and is due and payable the first day of the month following. On all water bills remaining unpaid twenty days after due a penalty charge of 5 per cent is added until the first of every month thereafter, when an additional 1 per cent is added to the 5 per cent until paid. The first of the following month after the bill is due a delinquency notice is forwarded to the owner of the premises, with a request to pay within five days. After this period, the account is turned over to the collector who gets in communication with the tenant occupying the house giving them an opportunity to pay the water charges, they in turn deducting the amount from their monthly rental. If the collector is unsuccessful, the water is shut off. Before the water is again turned on, all back charges must be paid, plus a $2.00 fee for the service.

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Fall Meeting New York State Sewage Works Association

The fall meeting of the New York State Sewage Works Association was held at the Onondaga Hotel, Syracuse, N. Y., Sept. 13, 1930.

Eighty members and guests were registered. Mr. C. A. Holmquist, President, presided and paid tribute to the memory of Kenneth Allen, founder and first president of the association. The announcement of the passing of Mr. Allen was a distinct shock to all present and the following a fitting resolution was adopted.

Resolution

The members of the New York State Sewage Works Association, assembled in meeting at Syracuse today, have been shocked and saddened by the announcement of the removal from our fellowship of our friend and first President, Mr. Kenneth Allen.

Many of us have had the advantage of personal contact and long friendship with Mr. Allen and recognize his sterling character, in his helpful criticism, his habit of thorough research and his sane and sound conclusions.

At all times he has preserved his kindly and helpful attitude and his sense of humor which endeared him to all his associates.

Therefore be it

RESOLVED: That we, his fellow members, in recognition of his life and work and his services to this Association, transmit this memorial to his family and spread the same upon our Minutes.

Following a brief business meeting, two papers were presented, one on "Chlorine Uses at Sewage Plants" by L. H. Enslow of the Chlorine Institute and the other on "Stream Pollution from the Operator's Standpoint" by Professor E. B. Phelps of Columbia University. The discussion of the papers was respectively opened by C. R. Cox and A. F. Dappert, both of the State Department of Health.

At the luncheon, Dr. George Ruhland, Health Commissioner of Syracuse, welcomed the members and gave a most interesting address on "The Relation of the Sanitary Engineer and the Health Officer in Community Health Protection."

In the afternoon an instructive inspection trip was made to the main sewage treatment works of the city of Syracuse, the Solvay lime wastes beds where the sludge is disposed of and to a small plant at Eastwood where separate sludge digestion and control were demonstrated.

After a dinner in the evening, a lively round table discussion with Vice President, Morris Cohn, presiding was held. R. S. Rankin, John F. Skinner and Harry W. Eustance led the discussion on the following topics, "Metal Preservation Above and Below Sewage Surface," "Garage Wastes" and "Experience with Small Pumping Stations." A paper prepared by Dr. J. F. T. Berliner on "The Ammonia-Chlorine Treatment of Sewage" was read by Mr. West.

The next meeting of the Association will be the Third Annual meeting and will be held in Albany at the time of the winter meeting of the New York State Conference of Mayors.

Tight Joints in Water Pipe Line

Tests of 18-In. Pipe Line for Water Supply of Frederick, Md., Showed Very Small Leakage

By C. J. REQUARDT

Of Whitman, Requardt & Smith, Consulting Engineers, Baltimore, Md.

THE City of Frederick, Md., recently installed about three miles of 18-in. cast iron bell and spigot pipe. Specifications for the work required a leakage under test of not more than 250 gal. per inch of diameter per mile of pipe per day. For the 15,000 ft. this amounts to 1.18 cu. ft. per minute. The specifications also required that the pipe be left uncovered uncovered until tests for leakage had been made.

The pipe was 18-in. deLavaud bell and spigot pipe as made by the U. S. Pipe & Foundry Co. Leadite was used for jointing material. The pipe was laid across country in a fairly straight line and with a cover of not less than 3 ft.

Immediately after the start of the work in the summer of 1929, the contractor urged that he be allowed to backfill over the pipe immediately upon laying and to fill the pipe with water as soon as successive points were reached where pipes could be capped or valved. The engineers, noting the careful work the foreman was doing and especially the excellent joints the pipe jointer was making, allowed the contractor to backfill immediately.

The pipe on installation was immediately put into operation. Test was postponed until the spring of 1930, about six months after completion.

How the Test Was Made.—In making the test, a centrifugal pump was used having characteristics of 50 gal. per minute at 3500 R.P.M. and 385 ft. head. It was a 2-stage pump, operated by a 25 HP. electric motor. Difficulty was experienced in the pump sucking air because the suction was attached to a pipe under but little pressure through one 1-in. lead gooseneck.

In starting the test it was found that the pump pulled air and gave false readings. The suction was then disconnected and three taps were made in the suction pipe and three lead goosenecks, each of 1-in. diameter, were placed. The pump was again started and as will be seen from the log of the test, the air trouble was eliminated and a good indication of the tightness of the line was obtained.

We expected small leakage due to the fact that the foreman and the city engineer the night before had run a 3-hour test under about 100 lb. mountain pressure which showed the leakage to be less than 30 gal. per minute. As this pressure was not sufficient, the test by the pump was deemed to be the official one.

As will be seen from the log, it was possible to obtain three 5-minute runs during the test in which the leakage was less than 26 gal. per minute.

Why the Line Was Tight.—Outside of the materials used, we look upon the tightness of this line as due to the careful blocking of the pipe; the cleaning of the bell and spigot ends; and the pride of the jointer in seeing that his jute was properly placed, with the pipes concentric with each other; that his jointing compound was uniformly heated and that all joints were poured without leakage and full in one operation. Further, we feel that the test was highly successful because the pipe was backfilled at once, eliminating differentials of expansion and contraction under action of the sun. Finally we believe that the pipe being filled with water and allowed to operate for a long period before the test was helpful in producing the tight line.

The pipe was installed under the advice of Whitman, Requardt & Smith, Engineers, of Baltimore, and Elmer StC. Maxwell, City Engineer. Ligon & Ligon of Baltimore were the contractors. Sam Wiederman was the superintendent and Clifford Cox was the pipe jointer. George A. Burke, is superintendent, and B. McCaffrey, is assistant superintendent of the Frederick Water Department. The illustration shows, in the front line, Messrs. Wiederman, McCaffrey, Cox, Maxwell, an inspector, Requardt and Burke.

The Testing Apparatus and Men Who Made the Test

Test of 18 in. Pipe of Frederick Water Supply, May 22, 1930

Meter in cu. ft.	Time	Cu. ft. per 5 min.	Cu. ft. per min.	Gage in lbs.
5057	9:08 A. M.	.....	.....	.....
5061.5	9:13 A. M.	4½	0.9	230-40
5065	9:18 A. M.	3½	0.7	230-40
5069.5	9:23 A. M.	4½	0.9	230-40
5075	9:28 A. M.	5½	1.1	230-40

Bleed valve opened at 9:30 and meter went back to 5074 in ½ minute showing air had been forced into line. Up to this time gage had been vibrating 230-240 but now gage stands at 236 steady. This would indicate all air is out of line.

Meter in cu. ft.	Time	Cu. ft. per 5 min.	Cu. ft. per min.	Gage in lbs.
5076.67	9:33 A. M.	1.67	0.334	236
5077.33	9:38 A. M.	.66	0.133*	236
5077.80	9:43 A. M.	.47	0.094*	235
5078.5	9:48 A. M.	.70	0.140*	235
5082.5	9:53 A. M.	4.00	0.8	.....

At 9:52 A. M. we noticed the meter start to move rapidly and looking across the field one-half mile away, saw a laborer had opened a fire hydrant on 18-in. line. This was closed but the effect will show on next 5-minute run.

Meter in cu. ft.	Time	Cu. ft. per 5 min.	Cu. ft. per min.	Gage in lbs.
5088.5	9:58 A. M.	6.00	1.2	.....
5094.5	10:03 A. M.	6.00	1.2	230
5100.6	10:08 A. M.	6.1	1.22	230

These last tests show air in line due to hydrant opening. Owing to lack of water in the town, this test was stopped and the pipe accepted.

*These average 0.122 cu. ft. per minute, or 26 gal. per inch per mile per day.

Water Works Financing and Accounting

Some of the Principles of Proper Financing and Accounting as Applied to Water Works Practice

By H. G. CALDER

Assistant Comptroller, Federal Water Service Corporation, New York, N. Y.

THERE are in business, including the professions, three factors, which if the business is to be successful, must be taken care of, and the success of the business will be in proportion to the efficiency with which those three factors are administered. Those three factors are, production, selling and financing—which includes the accounting function. Any one factor may be broken down into other departments or all three may be handled by one man. I personally believe that the three are of equal importance to a business, but without prejudice in favor of my profession, if I had to choose from the three in a business where I had my capital invested to the neglect of the other two, I would unhesitatingly choose financing as the most important. Any business capitalized in a manner suited to it, maintaining proper financial position which spends less money for expenses than its revenue must be a success whether it be a peanut stand or the United States of America.

Finance.—In examining this factor in business called "Finance" let us first look at the financial structure of a business. It is the plan by which the business is built. Like any other plan it should be followed so far as possible, but should be subject to change where the original plan proves impractical. The main point is that any water works, either municipal or private, should make definite financial plans in advance; it should plan the most economical way of getting its original investment and the most satisfactory mode of handling its operating financial requirements. There are engineers who could build a dam, or lay a pipe line, without any plans whatever, because they have had so much experience that the plan is in their heads. Men with sufficient financial experience can do practically the same thing. But they usually choose to make their estimates in advance on paper and select whichever method seems most profitable. To do this, they must be familiar with the various methods which might be used. But either engineer or financier must rely on some kind of accounting method to give them the final cost of their completed project.

The accuracy of that accounting is the determining factor of the accuracy of their future calculations. It is possible to keep accounts on the backs of envelopes and keep them accurately, but it is quite difficult. I knew a German druggist once who did just that thing. He kept his accounts very neatly on the back of an envelope, and had the essential information that he needed to operate his simple business. But if he had understood how to enter the same information properly, in a ledger, he not only could have done it easier, but he would have had far more information about his business. May I say that he ran one of the smallest businesses there was in a town of 40,000 population.

Reports.—To determine proper policies, the management should have reports showing the status and progress of the affairs of the business. The information may be in the books and files of the office, but the treasurer or auditor of the business should present the important facts about the business in such a manner that they may be readily grasped by others interested in the management. It is worth while before deciding on the type of report to be presented, to investigate the type of report furnished by others and to examine their methods to find whether they are practical for your needs. In making any departure from proven methods, it is wise to get expert opinions, from those qualified by experience to advise. Proper reports are as important to management as charts are to a navigator.

The hope of civilization is that one generation will learn from the mistakes that previous generations have made. The hope of modern business is that we will learn not to repeat past mistakes, and that we will profit by using profitable methods again and again until something better is discovered. Business history is kept in the ledger, and that business history in many cases is just like civil war history. One story is taught in the North and another is taught in the South. There are some broadminded and well informed educators who teach both sides impartially, and lucky the student who learns his civil war history from such a professor, and lucky is the business which has an accounting system which presents the true history of that business, disregarding predetermined beliefs. Guessing can largely be eliminated from such a business.

Policies.—Businesses are run according to the policies of the management either expressed or otherwise, and determining policies for the management of a water plant without accurate accounting information is like buying a grab bag at a church fair, you don't know how good it is until you have closed the deal and its too late to back out. In the water business you know when you get your bank statement—the notice that your notes are due—or that your warrants are due and you can't sell your bonds. The only difference is that with the grab bag, the suspense is soon over. There is a water business with close to a million dollars revenue a year which is nearly 30 years old, and has never paid a dividend—due entirely to improper financing and fallacious policies based on erroneous accounting. The engineering has been satisfactory and the growth of the plant has been ideal for a profitable venture, but the forgotten factor beat them.

So much for theory. One of the strongest arguments for proper accounting is that in many instances modern methods of handling records actually save money in the operation of the office itself.

Examples.—Here are a few concrete cases of the thing we have been discussing. A certain water plant was acquired by Company A. The construction accounts were in miserable shape and had not been transferred to the fixed capital accounts for five years. Upon analysis, an amount in excess of $20,000, representing work which was for the account of an outside company was buried in these construction accounts. It was billed (after being lost for two years) to the consumer and collected. The total cost of that analysis was less than $500. In another case an audit of a company disclosed an error in accounting which made something over $17,000 available for dividends which would have otherwise been closed in its capitalization.

You have all read of refunds on federal taxes. You may be sure that in most cases they called for expert accounting analysis before they were secured.

One other story. There was a merchant in the lumber and grain business whose credit limit at the local bank was $3,000. The records which he kept of his business were negligible, he could never furnish his bank with a complete statement of his financial condition or of his profit and loss. As a result of the limit of his credit at the bank, he frequently lost discounts on invoices which ran as high as 25 per cent. He finally called in a bookkeeper. The bookkeeper put his records in shape and furnished him with monthly statements, copies of which were mailed to the banker. The banker as a result of receiving definite information, and as a result of the knowledge that this man was keeping records of his business, increased his credit limit to $10,000 and then to $20,000—with the result that the merchant made the difference between 25 and 5 per cent or $17,000 annually. After three years of keeping books he discontinued the grain business because his records showed that it had become unprofitable. His business and his personal financial standing improved amazingly through definite knowledge of his affairs.

When an issue of bonds for a water works is submitted to a banker regular statements and proper accounting may be a difference between 5 and 7 per cent in interest paid on the bonds and may also be the difference between being able to issue $500,000 or $1,000,000 of bonds.

Don't make guesses based on misinformation—get the facts. And do not run a one-horse business—put them all to work.

Acknowledgment.—The above is an abstract of a paper presented at the 50th annual convention of the American Water Works Association.

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Public Water Supplies and Unlawful Bathing

The Connecticut Supreme Court of Errors on April 17, 1930, handed down a decision regarding the protection of public water supply from contamination by unlawful bathing. The decision was rendered in the case of a realty company v. the Borough of Wallingford, et al. Public Health Reports for July 11, comments on the case as follows:

The plaintiff corporation owned land upon which was a small pond. Water from this pond flowed through a brook to the reservoir and pumping station of the borough of Wallingford. The plaintiff set apart, for use by the public as a park, about 150 ft. of the land all around the pond. The land back of this strip was divided into lots for sale. Large numbers of people were invited to come and bathe in the pond and the privilege of bathing therein was offered to the purchasers of the lots not bordering on the pond.

Section 2544 of the General Statutes provided as follows:

> Every person who shall bathe in any reservoir from which the inhabitants of any town, city or borough, are supplied with water, or in any lake, pond, or stream tributary to such reservoir, or who shall cast any filthy or impure substance into such reservoir, * * * shall be fined not more than $100 or imprisoned not more than six months, or both.

The borough, through its water commissioners and superintendent of waterworks, called plaintiff's attention to the statute and also gave public notice that bathing in the pond would be a violation of the statute. Also the state commissioner of health caused notices to the same effect to be placed near the pond.

The plaintiff brought an action for an injunction to restrain the defendants—the borough, the water commissioners, the waterworks superintendent, and the state health commissioner—from interfering with the sale of its land and for damages. The borough filed a counterclaim, asking for an injunction against plaintiff's use of its premises as a pleasure resort or as a rendezvous for swimming, boating, or fishing or in a way that would render the waters unfit for water-supply purposes. The trial court found against the plaintiff in the action brought by it and in favor of the plaintiff on the counterclaim. The conclusions reached by the trial court were that the pond at the borough's pumping station constituted a reservoir within the meaning of section 2544; that the plaintiff's riparian ownership conferred only a personal and family privilege of bathing in the pond; that the proposed according of the privilege to the public and lot owners who were not riparian proprietors was an unreasonable use; and that, since the pond was entirely surrounded by land owned by the plaintiff, none of the lot owners was a riparian proprietor having, as such, bathing rights in the pond. The plaintiff appealed, but the judgment against the borough on its counterclaim was not appealed from.

The appellate court held that the judgment of the trial court was correct. Portions of the opinion follow:

> * * * A riparian proprietor is an owner of land bounded by a water course or lake or through which a stream flows, and riparian rights can be claimed only by such an owner. They are appurtenant only to lands which touch on the water course or through which it flows and which are used as a whole for a common purpose, not to any lands physically separated from the stream and the land bordering on it, although belonging to the same owner. * * * It is clear that the grantees or contractees, from the plaintiff, of lots separated from and not bordering on Pine Lake can have, of their own right, no riparian privileges in its waters. And any attempted transfer of the right made by a riparian to a nonriparian proprietor is invalid. (Citations.)
>
> Each riparian proprietor has an equal right to the use of the water to drink and for the ordinary uses of domestic life, although such use may in some degree lessen the volume or affect the purity of the water, and this right to such use extends "both to the owner himself and all living things in his legitimate employment." 27 R. C. L. p. 1085. The right includes use of water for drinking, culinary, and other domestic purposes, and for watering of animals. (Cases cited.) The right, being to use "ad lavandum et potandum," logically includes ordinary and reasonable bathing privileges by the riparian owner, his family, and inmates and guests of his household, in the stream or pond as well as in waters drawn therefrom. The trial court states, and the record indicates, that this right of the plaintiff was not questioned or involved in the present action; the proposed extension of the privilege to the plaintiff's grantees of lots and to the general public was the subject of the defendant's objection and notice of intention to resist. * * *
>
> Each riparian owner is limited to a reasonable use of the waters, with due regard to the rights and necessities of other such owners. It is the common right of all to have the stream preserved in its natural size, flow, and purity, without material diversion or pollution. A riparian proprietor has no property in the water itself, but a simple usufruct while it passes along. Though he may use the water while it runs over his land, as an incident to the land, he can not unreasonably detain, divert, or pollute it, unless he has a prior or special right to some exclusive or particular enjoyment. He must use and apply the water in a reasonable manner and so as not to destroy, or render useless, or materially diminish or affect, the legitimate application or use thereof by other riparian proprietors. (Cases cited.)
>
> Application of these rules readily demonstrates that the uses contemplated and threatened by the plaintiff clearly were extraordinary and unreasonable. * * * The conclusions reached by the trial court as to this feature of the case were warranted in law and fact.
>
> * * * The giving of notice of intention to protect the supply by preventing the contemplated injury by promiscuous bathing was not only fair to the plaintiff and prospective purchasers, but a proper means of minimizing damages. (Case cited.) The notices were appropriate, also, to a fulfillment of the duty resting upon the defendants to adopt such precautionary measures as are reasonably proper and necessary to protect the community served by the water supply from risk of infection.

Water Supply System for Airports

A Timely Discussion of the Method of Solving the Problem of Providing Adequate Water Supply for Fire Protection Purposes for a Rapidly Growing Industry

By S. F. NEWKIRK, JR.

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THE task of furnishing an adequate and reliable water supply for air ports is one that is causing no little concern to those who are responsible for water supplies. The rapidly increasing number of airports with the presence of unusually inflammable materials, many having little or no water supply for fire prevention and extinguishment, has brought to the foreground in many localities the question of how these airports are to be supplied. A fire loss of $1,600,000 in 14 fires has also called the attention of the aeronautical industry to the fact that some means of combating fires must be provided at air ports.

Aerial Transportation Increasing.—Air transport, business aviation and commercial aeronautics are here, and here to stay. The federal government is developing an extensive system of national airways which bids fair to become in time almost as comprehensive as our national highway system. Powerful revolving search light beacons, with flashing course-light projectors for indicating the direction of the airway are being installed at 10-mile intervals. At thirty-mile intervals boundary-lighted intermediate landing fields are being established and equipped.

United States air transport routes now total approximately 37,000 miles, of which nearly 12,500 miles are lighted for night flying. All of these airways and navigational aids, however, would be useless if we had no airports, just as light-houses and other aids to marine navigation would be of small value if there were no ports or harbors in which ships could anchor and find shelter.

Adequate Airports Required.—Progressive cities are determined to have adequate airports to attract air commerce and its accompanying industries, as they recognize the fact that they must provide themselves with suitable air terminals if they are to have places in the great air transportation system that is rapidly spreading over the country. Chambers of Commerce, civic bodies, and municipal and county organizations are wide awake to the need for efficient airports, with the result that a large number of airports are being constructed and projected. In a few years the municipality that lacks a landing field for airplanes will suffer in prosperity and esteem. In 1929, government traveling airport specialists visited 636 cities and delivered 251 addresses in municipalities interested in obtaining airports. A carefully selected chain of airports established in or near all cities and the most important towns is essential to meet the needs for landing of the many planes now in constant use, and to care for the great increase in the near future.

The location of an airport has depended, in most instances, upon the field available and cost involved, whereas climatic conditions, visibility, prevailing winds and general surroundings play an important part in the space required. Most airports are located a reasonable distance outside of a city on an arterial highway or main line railroad providing rapid transportation to the center of the city.

The Growth of Areonautics.—To emphasize the growth of aeronautics, it is interesting to note that 4,761 military and commercial airplanes were produced in the United States in 1928, and 6,034 in 1929, and on January 1, 1930, there were 10,596 holders of pilot licenses and 31,391 holders of student permits. Aids to aviation in the next feedral budget, beginning July 1, are $22,517,630—about one-half the amount allotted to merchant marine. The total distance flown by all aircraft during 1928 was 65,658,936 miles.

On January 1, 1930, there were 1,603 municipal, commercial or private airports, Army and Navy stations, Department of Commerce intermediate fields and other marked auxiliary fields, an increase of 556 in two years. In addition, there are more than 4,000 fields owned by states, municipalities, corporations, clubs, commissions and individuals, on which landings may be made, but which are not permanently recorded, as they are constantly changing in character, and a permanent record would be of variable value. Also, in 1,274 cities additional airports of one grade or another are under discussion.

In the construction of an airport much time is given to the study of a proper layout, drainage, clearance, grading and surface lighting, but little or no thought is given to water supply.

The Fire Rating of Airports.—The Aeronautics branch of the United States Department of Commerce, in their rating of airports when considering fire-fighting equipment, are guided in a large measure by various standards of the National Board of Fire Underwriters. The National Board has not published any standards for protection of airports, and standardization must not come too soon in a field so overwhelmingly in its ascendency and so profoundly subject to revolutionary advancement. The National Board and the aeronautical industry have differences of opinion regarding fire protection requirements, and the National Board is now awaiting the outcome of various tests before publication of requirements.

An airport is often located at a considerable distance from a public water supply, and the cost of extending the system is prohibitive. The rapid rate at which water is required during a fire requires large mains, so that even when airports are near a public supply, they are sometimes at a remote distance from an artery.

An airport in New Jersey has had two fires with a total loss of $500,000 and, quoting from a local newspaper, "No water was available on the field and firemen were forced to lay several hundred feet of hose and draw on wells on nearby farms." The nearest fire hydrant to this field is 1.9 miles distant, and the nearest water system artery, a 36-in. pipe under eighty pounds pressure, is 10,000 ft. distant. To supply this field satisfactorily it would be necessary to lay an 18 in. line at a cost of about $60,000, and an elevated tank would need to be provided for reliability. Under utility regulations the private water company nearest this port would need to extend their system upon receipt of a deposit of about $15,000, refundable as other consumers connected to the extension. This company would

realize that an extension meeting the requirements of the utility commission would give little fire protection and the water company would be willing to add that much additional in order to give better service. If this latter extension were made and elevated storage of 50,000 gal. and a ground storage of 500,000 gal. were provided, there would be a sufficient supply.

Requirements of Water Supply.—Where airports are so located that it is impractical to obtain a water supply from an existing system, a supply will need to be developed. This supply will usually be from wells, as it is seldom that an airport is located near a surface supply that has any appreciable dry weather yield. It will also probably be costly to provide sufficient wells and well-pumping equipment to maintain the rate necessary for fire-fighting, so storage will need be resorted to. The quantity required which, of course, will vary in different ports, will probably be too great for elevated storage, so a combination of elevated and surface storage will need to be resorted to. The surface storage supply will need to be raised to the piping system by fire pumps. In all cases where an adequate fire flow can not be obtained from an existing system, storage, both elevated and surface, should be provided. The elevated storage should be sufficient to supply the required fire flow for about 30 minutes, and the combined elevated and surface storage should be sufficient to meet the requirements for a period of two hours.

Ground storage does not need to be in expensive concrete cisterns. Large wooden tanks similar to those used by the government during the war could be used. Fire pumps should be housed in a detached building of incombustible material. Electric power could usually be used for driving pumps with internal combustion engines for stand-by service. Water mains should be of cast iron and eight inches should be the minimum size, with larger sizes determined by carrying capacity necessary from source to point of use. Hydrants should be of sufficient size to meet the standards of the National Board of Fire Underwriters and where possible should be in a structure with hose attached. Care should be taken in selection of hydrant locations so as not to interfere with flying operations. Post indicator valves should be used as much as possible.

Construction Types at Airports.—In conjunction with the study for a source of supply, it is necessary to know just how much of a supply is necessary and, in order to estimate, it is necessary to decide what fire-fighting facilities are to be furnished. This depends upon the type of construction used for hangars and the features of heights and areas. The type of construction generaly used is frame, sheet metal and masonry walls, with a wooden roof supported on steel or built-up trusses. The masonry type of construction with some variations is generally employed by the larger transport companies and many of the cities that have more recently built airports. The sheet metal hangar is extensively employed, and frame hangars are found at the old landing field. In some cases, hangars are used for general shop and repair purposes, and, in such cases, mezzanines are frequently constructed to provide storage facilities. Frequently the hangar is constructed with lean-tos on two sides, housing repair shop, heating equipment, offices and rest rooms.

Heights are necessarily great, and the clearance from floor to bottom of lower chord of the roof truss is steadily increasing as the size of airplanes is increasing. The feature of height is important from the fire-protection view point, as it affects the design of sprinklers and the efficiency of hose streams. At present there are none other than single-story hangars, but the aeronautic interests state that space is at a premium and provisions should be made for two-story hangars and for basements beneath hangars. Basements are objectionable because they form pockets wherein vapors may accumulate.

The area of a hangar is necessarily important, as in structures of large area fire protetcion becomes a serious matter. A standard hangar area should be only moderately large and increases in dimensions beyond the standard should only be allowed where protective appliances are provided, which will, through automatic operation, extinguish many fires in their incipient stage. Of even more importance, if the fire is not extinguished, these devices, such as automatic sprinkler systems, will cool the air down below the ignition point of the material in storage and will largely clear up the smoke, so that men can enter and extinguish the remaining fire. The areas of the older hangars are relatively small, that is, 6,000 to 8,000 sq. ft., but in recent years areas of 9,000 to 14,000 are common practice. The tendency at present is to considerably increase these areas.

Sprinkler Systems.—The aeronautical industry does not regard the installation of automatic sprinklers favorably, but fire prevention engineers are of the opinion that the nature of the occupancy is susceptible to protection by automatic sprinklers, and no convincing reason has been advanced as to the inability of automatic sprinklers to cope with fires in hangars. The arguments being advanced against the use of automatic sprinklers in hangars are about the same as were formerly advanced against the installation of automatic sprinklers in garages, but in fires in sprinklered garages, over a seven year period, the sprinkler operation in 97.8 per cent of the fires was satisfactory.

Tests made at the Newark airport on a sprinkler system equipped with automatic, thermostatically-operated, quick-opening valves indicate that such equipment will successfully control airplane fires liable to occur in hangars, and such equipment, with ceiling and floor sprinklers, will probably confine a fire to one plane unless the fire starts between two or more planes at the same time, in which event it is likely that the fire would be confined to the immediately adjoining planes without involving others in the hangar, and serious damage to hangar structures is not likely to occur. This type of equipment requires a large volume of water, about 3,000 gal. a minute. In addition to an automatic sprinkler system, inside standpipes and hose and outside hydrants should be supplied.

The total quantity of water required for most airports would be an elevated tank of about 50,000 gal. capacity and surface storage sufficient to augment the normal supply so that three 1,000-gal. fire pumps could be adequately supplied for a period of about two hours.

The question of fire protection at an airport is a real problem and one that is not so easily solved as might be expected, but an airport is principally a public utility and is responsible for loss or damage to a plane while stored in a hangar. In many hangars signs are displayed to the effect that the owner of the hangar is not responsible for any loss or damage to the plant. This is, of course, no protection if the owner of the plane can prove negligence on the part of the hangar management and the same rule will possibly be applied by the courts to this question that now applies to the storage of automobiles in garages.

Acknowledgment—The foregoing is an abstract of a paper presented at the 50th annual convention of the American Water Works Association.

Installing a 30-in. High Pressure Main Under a 5-Track Railroad

Protection for Both Roadbed and Main Secured by 60-In. Corrugated Iron Pipe Conduit Installed Quickly by the Jacking Method

LAST summer an industrial plant situated near Euclid Village, O., completed the installation of an intake and main system which will make the unlimited supply of water in Lake Erie available for its use. The entire system, as now in place, consists of 12,000 ft., of which 2,000 ft. are installed on the bottom of the lake as an intake and 10,000 ft. on land as a connecting main.

The Problem.—In laying the 10,000 ft. of pipe on land, the engineer in charge was confronted with the problem of installing a 30-in. main under the main line of the New York Central Railroad, which is situated between the lake and point of consumption. Being a main line railroad between Chicago and New York, this is an extremely busy road and it was imperative that the method used of placing the main would in no wise interfere with traffic on the road, which at the point of intersection with the main consists of five tracks. For making this installation there were two possible methods: the open trench method, which would require shoring the track, the issuing of slow orders, and a period of maintenance for a soft roadbed after the installation was completed. The other method was to jack a corrugated iron pipe conduit under the track and lay the pipe in the opening thus created.

Methods Considered.—A study of both methods revealed that the Armco jacking method would eliminate such bad features as slow orders, track maintenance and expensive shoring of the track. The estimated cost of both methods also showed a large differential in favor of the jacking method.

In making such an installation under a railroad which carries a large number of fast trains, the safety of workmen is an element to be considered. By using the jacking method all work is done below the level of the track, thereby practically eliminating the possibility of an accident from passing trains.

With these advantages to be gained from its use, the jacking method was chosen to make the installation. Armco corrugated iron pipe was chosen as the conduit because its long sections are particularly adapted to placing by this method.

Method of Installing the Conduit.—The first step in the installation was the digging of an approach trench to the level of the proposed line on the lower side of the track. In this trench the regular jacking setup, consisting of lining timbers set to an accurate line and grade, a backstop for the jacks, and a bearing frame to transmit the pressure from the jacks to the pipe, were placed.

When the jacking setup had been completed a section of 60-in. pipe, which was provided in 16 and 18-ft. sections, was lowered into place and excavation ahead of the pipe started. The material encountered was a

General Layout with Shovel Digging Approach Trench. The Pipe Jack and Bearing Frame Are on the Job Awainting Use

Fast Railroad Traffic Passed Over the Tracks at Regular Speeds While the Installation Was in Progress

hard virgin clay for the lower 60 per cent of the pipe and a clay embankment for the upper part. Both these materials had a sufficient amount of stability, which is important to the ease of installation by this method. As the excavation of an opening just sufficient in size to admit the pipe was completed, pressure was applied by the jacks and the pipe was forced into the embankment. When the first section was jacked completely under the track in this manner, the second section was lowered into place on the lining timbers and connected to the first by means of a field riveted joint and the jacking resumed. This process was repeated until a total of 100 ft. of pipe, the amount required to carry the main under the track, was jerked into place.

Using a 60-in. pipe as a conduit in this case gave ample room for laying a 30-in. main which was carried under the track without further delay.

Railroad engineers and inspectors who visited the job from time to time, were well pleased with the numerous features which this job presented towards the maintenance of traffic schedules, the lowering of costs during and following installation, and the assurance of safety it gives from a broken main.

Frank Thomas, engineer of Euclid Village, was responsible for the design and execution of the entire project. Charles W. Jackson, of Cleveland, was contractor for the job.

Michigan Water Purification Conference

The 5th annual Michigan Conference on Water Purification will be held Oct. 20, 21 and 22 at the Hotel Durant, Flint, Mich. The program is as follows:

Monday Morning

Introduction of Members.
Paper "Filter Gages"—Douglas Feben, Detroit

Afternoon Session

Paper "A Year in the Mt. Clemens Filter Plant"—Harry McEntee
Paper "Water Bacteriology"—Prof W. L. Mallmann, Michigan State College
Discussion—R. Sensabaugh, Use of Phenol Red Lactose Broth
Discussion—Department of Health Experiments with Simmons Citrate Agar

Tuesday Morning

Round Table—Plant Problems
Experiences with filter washing—H. W. Ward
Experiments with coagulants—C. Howard
Reconditioning Filters at Highland Park—Irving Dahljelm
Reconditioning Filters at Grand Rapids
Cross connections surveys—W. D. Loreaux
Business Session

Afternoon Session

Inspection Trip
Possibly a Golf Tournament

Evening Session

7:00—Banquet—Harry C. McClure, Toastmaster
John N. Edy, City Manager, Flint
H. S. Streeter, U. S. Public Health Service, Cincinnati, O.

Wednesday Morning

9:00 Paper—"Water Softening"—Walter A. Sperry
10:30 Paper—"One year's operation of the Saginaw plant"

Wednesday Afternoon

1:30 Paper—"The present status of the Taste Problem"—L. B. Harrison
2:30 Paper—"Taste Removal Problems at Pontiac"—R. A. Hoot.

John M. Hepler of State Department of Health, Lansing, Mich., is secretary of the conference.

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Ground Water in Southern Idaho

An investigation to determine the geology and underground water resources of the Snake River lava plain, an area of more than 16,000 square miles in southern Idaho, was begun in May, 1928, by the Geological Survey, Department of the Interior, in cooperation with the Idaho Bureau of Mines and Geology, Idaho Bureau of Reclamation, North Side Canal Co., Twin Falls Canal Co., Minidoka Irrigation District, and Idaho Power Co., under the general direction of Harold T. Stearns. An advance set of maps showing the direction of movement of the ground water under this vast plain and the location of the wells from which the measurements were obtained was released for public inspection August 15, 1929. The final maps for publication are now completed, but because the report can not be published for some time copies of the maps have been made available for public inspection at the district offices of the United States Geological Survey, 228 Federal Building, Idaho Falls, Idaho, and Federal Building, Boise, Idaho; the office of the Commissioner of Reclamation, Boise, Idaho; the office of the Bureau of Mines and Geology, Moscow, Idaho; and the main office of the Geological Survey, Washington, D. C.

Is Cloud Stratification Due to Series of Electron and Proton Shells?

By HALBERT P. GILLETTE

THE "Heaviside layer" is a shell of electrons about 26 kilometers (43 miles) above the earth's surface I have recently shown that by assuming that series of electron shells surround the sun, Bode's law as to the solar distances of planets can be explained. The same explanation applies to a similar law as to the distances of the moons of Jupiter and Saturn from those planets. In those cases there appear to be two series of electron shells, or perhaps alternating electron and proton shells, each series forming a geometrical progression in which the ratio is two. Finding this to be the case as to the distances of satellites, I inferred that clouds might exist in strata, whose distances from the earth's surface would form a geometrical progression. This inference was verified by data in Clayton's "World Weather."

On pages 160 and 168 of that book there are charts and tables from which the following facts have been taken. Nimbus clouds are most frequent at a mean height of about 700 meters (2,296 ft.); cumulus clouds at 1,400 meters; alto-cumulus at 2,600 meters. Here we see a well defined tendency of these clouds to be most numerous at elevations that are approximately terms of a geometrical progression series whose ratio is two. The strato-cumulus clouds are most numerous at a mean height of amout 1,080 meters and the cirrostatus at 8,600 meters, which ratio is approximately 1 to 8, thus indicating another geometrical progression.

If we divide the 700 into the 1,080 we get a ratio of about 1.6, which is very nearly the same ratio that I found for corresponding terms in the two series of distances of the planets from the sun and the satellites from the planets.

It is noteworthy that the wind velocity in these cloud strata is greater than that between the strata. This is explainable by the theory of electron-whirls, which I have advanced to explain cyclonic storms.

Clayton points out that high clouds usually appear before the lower rain clouds arrive, and that this sequence can be used in forecasting rain 24 hours ahead. He also shows that the upper clouds that form in sheets are usually inclined to the horizon, the inclination being downward when they are in advance of a storm, and upward when they follow a storm. He infers that the air ascends obliquely upward, but the electron theory offers a different explanation. Any shell of electrons or protons in the air is itself a magnet as a result of its rotation with the earth. Moreover it probably contains many cyclonic whirls each of which is a magnet; the whole forming a compound magnet. Hence, when the axis of any powerful magnet, such as the sun, a sunspot or a planet, lies in a position most favorable to pushing or pulling these terrestial magnetic whirls, there must result either an upward or downward motion. During a storm the whirls in an electron shell move upward, thus cooling the air that is carried with them, and causing increased cloudiness and ultimately precipitation. The downward inclination of the advancing upper layers of clouds, to be seen in Clayton's sketches, is evidence of an upward bulge of the electron shells beneath and to the rear. Contrariwise as to the upward inclination.

Ever since Sir J. J. Thomson used electrons to form artificial clouds in his laboratory experiments, it has been certain that electrons are factors in producing rainfall, but most meteorologists have hitherto regarded a study of electrons as being of little practical importance in meteorology. Clayton (p. 156) says: "Aitken has shown that condensation in (water) particles cannot take place without a nucleus, which is generally furnished by the fine dust in the air, although it is now considered that electrons or ions may also be nuclei. Without these nuclei supersaturation would be possible and when condensation began the water might fall in sheets, but as abundant nuclei are always present this condition has only a theoretical interest." I believe, on the contrary, that variation in electron density in the air is not only a matter of theoretical but of practical importance.

The existence of two doubling series of shells surrounding the earth seems to be best explained by assuming one series to be electron shells and the other series to be proton shells. This hypothesis may also be used to explain the periodic reversal of sunspot rotation. A table of cloud elevation and average cloud thickness on p. 168 of "World Weather" shows that the cumulus clouds are ordinarily twice as high and half as thick as the nimbus clouds; but this inverse relationship of thickness to height does not apply to the strato-cumulus clouds whose elevation is intermediate between those two, for the average thickness of the strato-cumulus is half that of the cumulus. If we regard the nimbus and cumulus clouds as being caused by electron shells, and the strato-cumulus by proton shells, a reason for this difference in cloud thickness emerges. The electrons are negatively charged and the protons are positively charged, and there may consequently be a difference in their respective effects on condensation of moisture.

While the word "shell" is a fairly good one to designate the Heaviside "layer" of electrons, and the like, it should not be inferred that the electrons in such a shell are all rotating with the same angular velocity. It is more likely that each shell is composed of somewhat independent zones of electrons, for the difference in velocity of the "belts" of Jupiter indicates a zonal grouping of its atmosphere. Similar zonal arrangements exist in other planets.

If there is a doubling distance series of electron shells surrounding the earth, the first shell having a mean elevation of 700 meters, then there should be a shell having a mean elevation of about $32 \times 700 =$ 22,400 meters. The Heaviside layer is about 26,000 meters above the earth, and therefore approximately fits this doubling distance series.

In another article I have pointed out that the length of time between radio echoes indicates the existence of two doubling distance series of electron (or electron alternating with proton) shells. Magnetic pulses, measured by magnetographs, also indicate the same series of shells. Hence the existence of cloud strata forming two doubling distance series serves to establish more firmly this electron and proton shell theory.

Doubling distance series are to be found both in planets and the satellites of planets, thus adding striking evidence of the intimate relationship between the earth and other members of the solar system. Such

relationships serve to emphasize the importance of not confining one's meteorological researches to phenomena on this globe of ours. Conversely such relationships indicate how an astronomer may learn more about sunspots by studying terrestrial air-whirls. Even the existence of invisible planets may be proved by weather cycles that are scribed in geological strata. The boundaries by which we have fenced off our departments of science are purely artificial. Therefore it is wise at times to push aside all man-made fences.

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Financial Statistics of City Governments for 1928

The Department of Commerce announces a summary of the financial transactions of the 250 cities having a population of over 30,000 for the fiscal year 1928.

The total payments for operation, maintenance, interest, and outlays for permanent improvements for cities having over 30,000 population were 79.8 per cent greater than similar payments of the government of the 48 states, and 0.8 per cent less than those for the Federal government for the fiscal year 1928.

Preliminary statements for each of the cities have been released for publication as rapidly as the reports were received, the first of these statements appearing March 8, 1929. A summary, by cities, will be available within a few weeks giving financial statistics which will show assessed valuations and tax levies, revenues collected, governmental-cost payments, and indebtedness.

Expenditures.—The payments for operation and maintenance of the general departments of the city governments of the 250 cities for the fiscal period 1928 amounted to $1,853,232,348 or $42.63 per capita. In 1927 the comparative per capita for operation and maintenance of general departments was $40.98, and in 1917, $19.07. Payments for the operation of public service enterprises, as waterworks, electric light plants, and similar enterprises amounted to $164,154,462; interest on debt, $342,100,311; and outlays for permanent improvements, including those for public service enterprises, $1,036,635,298. The total payments in 1928, therefore, were $3,396,122,419; in 1927, $3,324,386,351; and in 1917, $1,108,021,565.

The per capita net governmental-cost payments for operation, maintenance, and interest for 146 cities covered by the various census reports since 1903 were $54.43 in 1928, $52.64 in 1927, $24.58 in 1917, and $16.41 in 1903.

The total include all payments for the year, whether made from current revenues or from the proceeds of bond issues. Proceeds from the issuance of debt obligations are not considered revenue receipts.

Of the 250 cities covered by this report only two were lacking in revenues sufficient to meet all operating expenses and interest, while 68 realized enough revenues to meet all their payments for expenses, interest, and outlays and to have a balance available for paying debt.

Of the total municipal payments in 1928, 54.6 per cent was for operation and maintenance of general departments; 4.8 per cent, operation and maintenance of public service enterprises; 10.1 per cent, interest on debt; and 30.5 per cent, outlays for permanent improvements.

Of the payments for operation and maitnenance of general departments 38.4 per cent was for education; 19.7 per cent, protection to person and property; 8.6 per cent, general government; 8.5 per cent, highways; 7.6 per cent, sanitation or promotion of cleanliness; 6.4 per cent, charities, hospitals, and corrections; 5 per cent, miscellaneous; 3.4 per cent, recreation; and 2.4 per cent, conservation of health.

The percentages for 1928 show but little change from those for 1927, the largest in each of the years being for education and the smallest for conservation of health.

Of the total payments for outlays for permanent improvements, the principal items were 389,688,125, or 37.6 per cent, for highways; $178,675,794, or 17.2 per cent, for education; and $156,135,016, or 15.1 per cent, for public service enterprises.

Revenues.—The total revenue receipts for the 250 cities for 1928 were $3,114,169,311 or $71.64 per capita. This was $754,682,190 more than the total payments of the year exclusive of the payments for permanent improvements, but $281,953,108 less than the total payments including those for permanent improvements. The revenue receipts included $1,993,265,137 from general property taxes; $69,956,211 from special taxes; $95,487,471 from license taxes; $249,562,380 from special assessements; $166,289,426 from subventions, donations, and pension assessments; $140,656,885 from interest, rents, and highway privileges; $297,957,505 from earnings of public service enterprises; and $100,994,296, the remainder, from poll taxes, fines, forfeits, and escheats, and earnings of general departments.

The per capita net revenue receipts of 146 cities covered by the various census reports were $72.11 in 1928, $69.77 in 1927, $31.97 in 1917, and $21.14 in 1903.

The net indebtedness (funded or fixed debt less sinking fund assets) of the 250 cities amounted to $5,828,-141,561, or $134.07 per capita, in 1928, this being an increase of 6.4 per cent over that for 1927. The per capita net debt of 146 cities covered by the various census reports was $139.63 in 1928, $134.27 in 1927, $80.75 in 1917, and $44.71 in 1903.

While there was an increase of $337,288,881 in net debt for the 250 cities as a whole, 113 individual cities showed a decrease in their net indebtedness.

A comparison of the aggregate increase in net indebtedness with the total payments for outlays discloses the fact that 32.5 per cent of the permanent improvements for 1928 were financed from proceeds of bond issues.

Assessed Valuations and Tax Levies.—For 1928 the assessed valuation of property subject to ad valorem taxation for city purposes was $77,849,280,583 for the 250 cities having over 30,000 population; and the amount of taxes levied for the city governments was $2,100,823,905, or $48.33 per capita.

Independent Divisions.—These statistics cover the government of the city corporation proper, and also independent school districts, sanitary districts, park districts, and other independent districts practically coextensive with the cities. They also include a per cent of the financial transactions, debt, and tax levies of the county governments for cities having over 300,000 population, in order that the statistics for such cities may be comparable with those for other cities in this class in which the ordinary county functions are performed by the city government.

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ANNUAL MEETING OF PENNSYLVANIA WATER WORKS ASSOCIATION.—The 35th annual meeting of this association will be held Oct. 22, 23 and 24 at Atlantic City, N. J. F. S. Purviance, Room 327, Telegraph Bldg., Harrisburg, Pa., is secretary.

Mechanical Accounting for Municipal Water Works Departments and Companies

The Application of Machine Accounting and a Rough Idea as to Their Value and the Savings to Be Obtained by the Adoption of Such Methods

By P. H. HUTCHINSON

Public Service Division, Burroughs Adding Machine Co.

THE various classes of accounting work discussed in this paper are distributed somewhat as follows:

	Per Cent
Customers Accounting	50
Payroll Accounting	15
Materials and Supplies Accounting	15
Accounts Payable	8
General Records	8
Reporting Work	4

When the assistance of machines was considered it was first applied on the largest group of work; namely, Customers Accounting. The adoption of mechanical accounting in this department has been very popular and is today almost universal. It is considered that it pays to use large machines whenever the number of meters to be handled exceeds 3,800 per month. Smaller machines with fewer automatic features are available at a very reasonable price where a smaller number of meters are in service.

Many of the large utility groups and also many of the individual companies have gone further than to simply introduce machines on this work by divorcing themselves from ledgers in favor of what is known as the "bill stub plan" or "Baltimore Plan of Bookless Bookkeeping."

Advantages of Machines.—Let us consider what the attraction has been that has drawn so many to use machines on customers accounting. The answer is the old slogan of "Improved Production at Decreased Costs." The improvements are:

First—Neatness: Better looking bills and more legible internal records.

Second—Accuracy: The bill, cashiers coupon, and ledger record cannot differ; the consumption is proved to be the difference between the readings; the extension of the quantity used by the rate applicable is guaranteed and the revenue is certain because it is the amount of each bill added as it is printed.

Third—Control: There is a stipulated total of what bills have been sent out and any defalcation can be easily detected because cash received plus uncollected accounts must check to the amount of bills printed.

Fourth—Speed: The machines used can prepare the bills, coupons, ledgers, and revenue statistics at a production of from 700 complicated accounts to 3,000 simple single line accounts per machine per day.

Savings from Mechanical Accounting.—While all of these very desirable results are being obtained, money is being saved as the accounting cost can be reduced on an average of about 25 ct. per account per year. On that basis, on 10,000 accounts about $2,500 can be saved each year. When a main extension is considered the popular ratio is that the investment should not exceed five and a half times the return. That means at a 50 per cent operating ratio to earn $5,000 gross revenue or $2,500 net, the justified investment would amount to $27,500. To earn the same net return with a Customers Accounting installation, using the most up-to-date equipment, the investment would not exceed $6,000 including the billing machine, automatic addressing equipment with plates and plate cabinets, binders for ledger stubs, fireproof filing equipment and automatic stamping and sealing equipment.

Mr. John L. Conover of the Public Service of New Jersey, who have about 1,200,000 meters, states in a paper on Customers Accounting that his organization realized a saving in labor alone of $300,000 per year by introducing a machine operated stub plan.

A private water company with 18,000 customers saved about $12,000 per year by introducing the same system and at the same time changing over from monthly to quarterly staggered billing.

Many water departments and companies have installed machine methods on their customers accounting work obtaining additional results and at the same time realizing a saving sufficient to cover their equipment investment in from one to two years.

Utilities that had obtained such desirable results on their largest group of work naturally turned their attention to the other half of their accounting problem, applied the same principles and obtained the same results.

Application to Payroll Accounting.—Let us take Payroll Accounting as the class of work next in importance. To get the best results from personnel the employees must have 100 per cent confidence in the company and the men they work for. If an employee does not receive his or her pay check regularly and without waiting, that confidence which is so important and valuable is undermined and often ruined. A company or department of any size by using machine methods on payroll work can have available before the end of the following day the earnings of each employee, for the period to date, and the accumulated labor expense charge to each account, for the month to date. When it comes to pay day there is no tedious work to be done, no errors to be made in the rush and no overtime is necessary to get the pay checks to the staff on time.

The original data from the timekeeper goes direct to a machine operator who extends the hours worked by each man on each account at the man's rate. The machine product being in units is sorted and posted two ways. First, to the man's accumulated earnings to date and second, to the accumulated expense charges to date by accounts. When it comes to pay day the work is very simple and straightforward. Machines are in use which prepare at one time at the rate of up to several hundred per hour all the necessary records:

1. The Employees Statement of Wages.
2. The Pay Check.
3. The Employees Income Tax and Earnings Record.
4. The Payroll List.

5. The Check Register Sheet for reconcilation with the Payroll Bank Account.

These machines accumulate the gross pay, make the necessary deductions, ascertain the net pay, and print and protect it on the check together with the date and consecutive check number. At the same operation the gross pay, net pay, and deductions for all employees are added and totaled. If payrolls are paid by cash the same routine can be followed except that a pay envelope is printed instead of a pay check.

Materials and Supplies Accounting.—These are handled in much the same way as the payroll. All receiving reports, issues and returns come to the office in skeleton form showing only the class of stock and quantity and are priced and extended by the machines. Totals are added while this extending is done to get the day's cost figures and to obtain the figures to control the postings to the stock records and distribution cards. All postings to the stock records and distribution accounts are made by machine and all work is balanced as it is performed. Each month, if desired, an inventory list is prepared and the whole or any part of the physical stock can be verified. Material accounting is one that has always presented a ticklish problem from the point of control and it is often difficult to ascertain whether shortages are due to defalcation, carelessness in not preparing issue tickets or poor accounting. The adoption of machine methods on this class of work has made large strides in the right direction by making the accounting fool-proof and thereby pinning the responsibility for any shortage on the storekeeper, who, in turn, is going to be more particular about getting a signature for everything that goes out of his store.

Accounts Payable, General Records and Reporting Work.—Up to this point we have considered methods of handling 80 per cent of the accounting problem. The remaining 20 per cent covers Accounts Payable, General Records and Reporting Work. The size and type of the company or department would decide the machine requirements on these activities. Where the quantity to be handled is large enough, special machines can be used, but the work can be just as easily done on the payroll or materials machines by the addition of special features to handle any additional operations.

In the small utilities where the volume of work is not large all accounting can usually be handled by two machines or even in some cases by one.

Many municipal departments use their customers' accounting machines to handle water, tax and assessment billing.

Mechanical Accounting for Small Units.—Some of you will contend that while it would pay large properties to adopt machine methods on their general accounting it would not work out so well on a smaller unit. The same question arose in the first pages of customers' accounting machine methods and yet it has proved worth while to both large and small utilities.

Accounting machines today are sufficiently flexible to permit of many classes of work being performed on one machine and it rests with each person to ascertain whether a thing can be done before they decide it cannot.

Now it is not to be deduced from this paper that machine methods are the only thing and that anyone who does not use machines for everything is behind the times. I am very much against the individual who walks into an office and immediately decides that everything is wrong and should be changed to his system. The reason possibly is that that individual knows only one system, and while the system may have worked well somewhere else, it may not fit at all well. In working out a system, one must look to the old-timers in an organization who know the business. What was done before was done to give them the information they wanted and there must have been a very good reason for adopting the method already in force or it would not be there. The axiom is, do not change a system unless the only way to improve it is to change it. If it is not working properly find out why.

How to Analyze Need for Machine.—Mr. W. H. Leffingwell in one of his books suggests that in making an examination of a system in force the following questions should be answered:

1. Is the work now being done satisfactorily? If not, why?
2. Is it due to some defect in the workers, or is it inherent in the operation?
3. In what particular form is it unsatisfactory?
4. Do the workers object to the work? If so, what is the objection? Is it a valid one?
5. What does the factor of time mean in this operation? Is it important to reduce the overall time?
6. What does it cost to do the work?
7. Can it be done more cheaply by hand by improving the operation?
8. What advantage is to be gained by having the work done by machine? Will it save labor, time or drudgery?

Having thus analyzed the need for a machine and having decided that a machine is necessary set about finding the proper machine for the job.

The foremost machine companies catering to the needs of public utility organizations have men specialized in every branch of public utility accounting and they will willingly make a survey of your work and submit their recommendations and proposals. Having received the proposals probably the best way to decide as to the merits of each is to ascertain from other utilities using similar equipment what their experience has been. If these users are willing to supply information on the following lines you will have something very definite to work on:

1. Production obtained.
2. Errors as per cent of items produced.
3. Speed and facility of paper handling.
4. Amount of investment.
5. Operating cost first year.
6. Operating cost following years.

So much for what machines will do in connection with Water Utility Accounting and how to select them, so now in conclusion let me enumerate a few DON'TS relative to machine methods:

1. Don't expect any system to work without proper supervision or planning.
2. Don't expect the machine to go around and collect the work, it can't do it. There must be a regular feed of work to the machine to get results.
3. Don't expect a machine to perform its allotted function under poor operation or improper handling. See that the operator really knows how to operate the machine.
4. Don't forget to have your machine serviced regularly.
5. Don't put a machine to work until the work is ready for the machine.

Acknowledgment.—The foregoing is an abstract of a paper presented at the St. Louis Convention of the American Water Works Association.

SEWAGE DISPOSAL WORKS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. DOWNES, Associate Editor

Supervising Engineer, the Plainfield and Dunellen, N. J., Sewage Disposal Works

With the British Sewage Works Operators: A Review of the 1929 Proceedings with Editorial Interpolations

THE Proceeding of the Association of Sewage Works Managers for 1929, just at hand offers a number of interesting parallels between the minds and work of the British workers in this field and their American cousins.

Research.—Right at the start off the report of the Honorable Examination and Research Secretary says, "Progress with regard to the research scheme has been somewhat disappointing although those members of the Association who are already imbued with the 'Research Spirit' have continued investigation of their respective problems, very little in the way of co-operation and collaboration has been achieved. The reason for this is difficult to explain. Is it that in connection with research in this country, there has always been a certain amount of feeling—a combination of jealousy and desire for secrecy—which seems difficult to eradicate?

"Has research become commercialized and are scientists losing their respect for the purely scientific and academic side of their profession in favor of the attractions of its commercial attractions? There is food for thought in these suggestions."

Yes, Cousin John, it is "that in connection with research in this country, there has always been a certain amount of feeling—a combination of jealousy and desire for secrecy—which seems difficult to eradicate," but you need not limit your statement to "this country." America has a bad case of the same disease. In fact that jealousy complex seems to be an integral part of the scientifically inclined mind.

The second part of your statement or question, "Has research become commercialized" can also be answered in the affirmative. And workers do favor the attractions of the commercial application rather than the scientific or academic side. We feel that this is inevitable and to a large extent as it should be, considering the source of funds for carrying on much of the research work and the fact that in no other way can the worker secure compensation for his labors. With this phase we are content but with the narrow minded jealousies that make scientific workers rush madly into print for fear some other worker will steal his thunder by announcing first that B-Whatisit is not a true Thingamagig but a para type, we have no patience whatever. Nor have we any patience with the pure scientist who goes out of his way to belittle the work of his fellows by heckling criticism, born of the aforementioned jealousy.

Such persons stand in the way of progress in the art and they will do so until someone finds a way to change human nature as applied to pure scientists.

Any apparent lack of cooperation among practical workers in the field of Sewage Disposal in America deserves an entirely different explanation which we believe will apply also to our English cousins. These men are willing and eager to give, to take and to exchange ideas. They are handicapped by lack of opportunity to exchange ideas and by the immense volume of routine work necessary to keep their plants in operation. Every contact with fellow workers seems to fill these men with good intentions along cooperative lines which intentions are subsequently lost sight of in the mass of detail required to make the local wheels go round smoothly and accomplish all, and in most cases a little more than, they were designed to accomplish.

The Chemist and Sewage Treatment.—Another writer. Mr. J. Herbert Spencer, in "Some General Thoughts on Sewage" refers to an anonymous contribution to "Surveyor" entitled "Foot Rule or Slide Rule" which he says "Rather over-accentuates the unnecessary and invidious, but all too prevalent distinctions between the theoretical and the practical man."

Mr. Spencer goes on as follows: "It seems, almost, that the ideal sewage specialist should have a prolonged general science and chemistry course followed by a few years devoted to biology and bacteriology and then an adequate training in engineering." "With such a grounding, he might, after a lifetime devoted to applying his accumulated knowledge to the special problems of sewage, claim to speak with authority on the subject." Since such training is impossible he suggests collaboration and points out that the great obstacle in the way of collaboration is the fact that each branch speaks a different language, a different technical jargon.

With the above introduction Mr. Spencer proceeds to describe sewage through the eyes of the chemist. He states that sewage treatment is very difficult because it is a process for removing last traces which is the most difficult thing in any chemical process. In so far as sewage treatment is a chemical reaction it would be an advantage to have a strong sewage to treat, because in accordance with the law of mass action the greater the concentration the faster the reaction. Not that a better effluent would result but that it would be easier to get a higher percentage removal. If one could treat a raw sewage containing 5 parts per 100,000 of 0 absorption value so as to give an effluent containing but 1 part, then a double concentration of the same sewage containing 10 parts in the raw, would yield not 2 parts in the effluent but say 1.8 owing to the more rapid reaction.

Since a stronger sewage suggests a smaller total flow, he reasons as follows: The result would be still further improved because, with the lower flow, the sewage would remain longer in the works.

"One practical conclusion from this reasoning is that it would be of advantage to exclude so far as possible purely diluting waters such as surface drainage—until after treatment. Suppose that in the example given above the increase in oxygen absorption from 5 to 10 parts is due to exclusion of such diluting water and that consequently an effluent is obtained with a figure of 1.6 instead of 1.0. If the diluting water be then admitted, AFTER purification, the liquid entering the river will have a figure of only 0.8."

For the Practical Operator.—Colloids, Spencer, defines as not any particular substance or class of substances but any substance too finely divided for simple physical separation and not sufficiently fine for rapid chemical treatment.

They are the bugbear of sewage disposal; at once the despair of the manager and the cause of his existence.

The following condensed statement from the lecture will be of value to the practical operator who has not the time to go deep into the theory of the matter: The particles remain in the colloidal state because they all have the same electrical charge either negative or positive. Hence they repel each other and remain separated. When any substance having opposite electrical charges is introduced into the suspension attraction results between opposite charges and the particles come together with resultant coagulation. With the particles coagulated into large groups they may be separated by gravity.

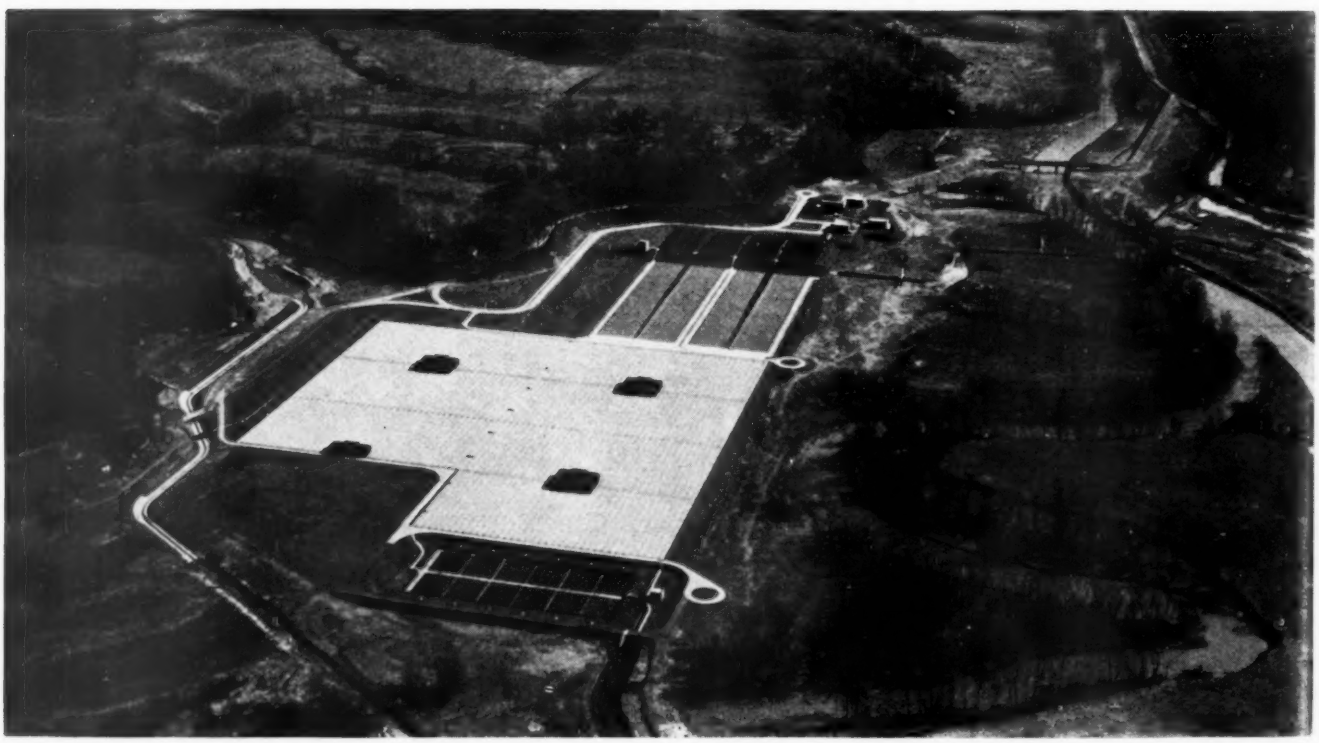
In a further attempt to bridge the gap between what the ideal works manager should know and what it is possible for him to gather in the short span of a single life Dr. Sciver has a short lecture on the elements of bacteriology and J. P. Todd on the principles of electrical measurements while W. S. Jackson, inspector for the West Riding Rivers Board for Sheffield and Rotherham gave an extensive paper on Stream Flows, Storm Water Overflows and Separating Weirs. The latter give principles of measurement and formulae with numerous diagrams for 3x D.W.F. and 6x D.W.F. He states that "These storm water overflows are a necessary evil on all combined sewerage systems and, in the writer's opinion, there is not yet a satisfactory design looked at from the point of view of rivers polution and the correct reduction of the flow to the purification works."

Successive Separation in Sewage Plants.—Mr. F. C. Temple, Chief Town Engineer, Jamshedpur, India presented a paper on *Successive Separation in Sewage Disposal Systems.*

While the discussion of this paper developed that some of his hearers characterized his work as dreaming and idealistic it seems to the reviewer that he has set down some very sound principles of sewage disposal which we might well take time to consider.

He says, "In all forms of (sewage) apparatus organic changes and separation both occur to a greater or less extent. Neither takes place without the other. From time to time in the history of scientific sewage disposal, there have been attempts to secure maximum organic change and maximum separation both together in the same tank" "The hope of the early experimenters of complete purification of sewage in one process was given up long ago—"

Speaking of two story tanks he says: "The great defect of these installations is that they try to do too much at one time in the same tank. The separation of solids and liquids is begun but is never completed, because the sludge is retained in the same tank for digestion. The products of digestion of the sludge, under these conditions, interfere with the separation and also interfere with other desirable action in the upper chambers. The more frequently the sludge is removed the better is the action and the clearer and more amenable to final treatment is the effluent passed on to the percolating filters. . . . The logical conclusion is that the lower chambers should only be made of such size as to contain that quantity of solids which will settle between



Sewage Treatment Plant, Akron, O. J. E. Root, Engineer of Sewerage. Metcalf & Eddy, Boston, Mass., Consulting Engineers

very frequent withdrawals of settled sludge to separate sludge digestion tanks."

"The ideal arrangement in a continuous flow tank and filter plant would be continuous removal of the solids from every part of the bottom of the tanks as fast as they are deposited."

"An essential feature of (the separate digestion) process is the separation of the liquids at the first possible moment in the settling tanks from the solids, with the minimum of liquifying action. It is the direct antithesis in this respect of the two-storied tank . . . At Birmingham elimination of the septic tank action eliminated also the coagulation of the solids in colloidal solution. The single settling action failed to separate (the colloids) and much other solid matter. The whole treatment of these solids, and the colloids, was thrown upon the percolating filters." It is in the coagulation and separation of these solids, according to Temple, that the bio-aeration, introduced between the settling tanks and the percolating filters at Birmingham and Croydon, was effective, though it was not originally introduced for this purpose, but as a complete treatment.

The ideal plant suggested by Temple would have 10 different separations between solids and liquids as follows:

I Grit Chamber; II Screen; III Preliminary settling in tanks 60 ft. long and two story design but with the lower chamber of very small proportions and arranged to be cleared almost continuously into digestion tanks; IV the sludge should be digested in plain tanks under gas collectors and the gas collected to be used for power to operate the plant. The digested sludge should be dried on beds, V, with possibly a preliminary dewatering treatment (Va). Proceeding with the liquid from III settling tanks, he proposes 4. Bio-Aeration; 5. Secondary Settling Tanks; 6. Sludge drying. 4a. Separation aeration and return of a portion of the A. sludge.

The reviewer believes that 6, drying of the excess activated sludge, will not normally be as simple as that, and that digestion of this sludge would form an additional separation (VI).

Bleaching Powder as an Auxiliary Treatment.—Mr. Herbert Bell, manager and chemist, Barnsley, considers the use of bleaching powder something more than a means of odor control as the result of his experience both at Barnsley and at Stratford-on-Avon.

He used bleach in 1911 at Stratford-on-Avon with excellent results applying three principles which he says were "rediscovered by our American friends in 1925." These principles were prechlorination, split chlorination and the advantages of treating fresh sewage. The latter he applied by cutting out the septic tanks and using a single tank for sedimentation only, and this tank was cleaned once a week. In an earlier attempt to control odors by the use of electrolitic chlorine the septic tank had been housed over as a further measure of odor control but this added to the H_2S content to such an extent that it absorbed all the chlorine without materially reducing the odors.

Bleach was added only when there was a positive reaction for H_2S in the air above a shaken sample and the dose of bleach was adjusted to a point at which this test was negative. The test for H_2S was the exposure of lead acetate paper above the shaken sample taking care that the test paper should not come into contact with any of the liquid.

He says "The deodorization appears to be more successful when the tank effluent can be maintained with a slight excess of free lime" and less bleach was required under such conditions. Economy was found in adding lime to save bleach. (Probably not true at present chlorine prices.)

At Barnsley it had been the practice to divert a portion of the flow from the bio-aeration tanks to certain trickling filters when the sewage was strong and septic. The cost of pumping the sewage to these filters was high and it was thought that the application of bleach ahead of the aeration unit would keep the sewage fresh and "Also encourage the aerobic organisms." The results of experiments along this line were so good that the method was adopted as standard practice.

Observing that while bleach prevented septic action it had no apparent inhibitive effect on oxidizing bacteria in trickling filters, Bell used bleach to "fortify" returned activated sludge which showed any sign of septicity with excellent results. From 18 to 30 P.P.M. of available Cl. was added to the returned sludge.

He also succeeded in bringing back to normal the bio-aeration tanks at times when they had been upset by sudden overloading, by the use of bleach and worked these tanks at considerable overload by the same means.

Bell also succeeded in using 1.65 grains per gallon of bleach in place of 2:75 grains of alumino-ferric as a precipitant at times when the sewage was so strong as to require a precipitant.

In his case, also, bleach was found to be effective in controlling the filter fly.

Cost Keeping for Sewage Disposal Works.—A costing system for sewage disposal works was presented by W. F. Freeborn, Cost Clerk, Manchester Corporation Rivers Department. The intricacies of the system outlined would delight the heart of any accountant but would drive an operator to the mad-house. It would be absolutely impossible to abstract this paper in an intelligible manner since it must be taken as a whole or not at all.

Fortunately the author had the grace to state that the system would require a separate costing department preferably at city headquarters.

The Epsom Plant.—Edward R. Capon describes the sewage works for the town of Epsom with a drainage area of 4,424 acres, a population of 26,500 and a D. W. Flow of 1¼ M. G. D.

In the present works are included broad irrigation, contact beds and Simplex surface aeration system of bio-aeration. The latter is the main point of interest at present as representing the climax of a long period of changes made in an attempt to keep up with the demands on the plant.

Septic tanks, contact beds, sludge lagoons and compressed air aeration tanks were among the things left in the discard by progressive development.

Preliminary settling tanks in advance of the aerators had, after considerable operating experience, been bypassed and finally turned into additional aerating units. Unsatisfactory experience with the "settling areas" in the aeration units had lead to the abandonment of this feature in favor of entirely separate settling tanks following the aerators. Finally instead of treating each aerator as a separate unit in parallel with the others, all of the sewage is now passed successively through each of the 12 aerating units in series and thence to the resettling tanks.

A 14 H. P. motor is provided for aeration and the power actually used is 11 H. P. (for 750,000 G. P. D.)

Sewage remains in the works for 14 hours and the 4-hour oxygen absorbed is reduced from 5.25 to 0.60.

Huddersfield Bio-Aeration Plant.—Huddersfield by the process of eliminating various methods of treatment which have not worked in the past has also arrived at bio-aeration as the coming method and has adopted the

Haworth paddlewheel system for an experimental plant of approximately 1 M. G. D. capacity.

This plant is described by W. D. Scouller.

The sewage consists of domestic waste 4 parts, textile wastes 3 parts and chemical wastes 2 parts. The chemical waste, however, dominates the situation having a 4-hour oxygen absorption value of 50 parts per 100,000 while the combined domestic and textile waste has a value of 20 parts. A large part of the chemical waste originating at a point near the works is separately piped and given preliminary treatment.

Effect of Iron Salts on Bio-Aeration.—Iron salts form a large part of the chemical waste and laboratory tests show that a small portion of iron helps purification but increased doses interfere with purification until at a concentration 10 parts per 100,000 purification stops. Gradual reduction of iron in the sewage leads to improved purification but abrupt cutting off the iron brings a drop in purification from which recovery is very slow.

A 13 per cent sludge was used and 30 H. P. was required per M. G. for aeration. This treatment resulted in a 4 hour oxygen absorption of 14-16 parts per 100,000.

Chingforf Sewerage and Sewage Disposal.—Mr. Martin states that Chingford covers an area of 2,807 acres and has population of 15,000. Early sewerage was on the combined system but more recent drainage was on the separate system. The works occupy a total area of 33¼ acres.

The plant consists of detritus tanks, screens primary and secondary sedimentation tanks and trickling filters, the latter are circular and fed by Simplex revolving distributers.

The 8 trickling filter units provide a total area of 45,000 sq. ft. and are 4 ft. deep which is considered ample for 20,000 persons.

The 4 primary settling tanks are 27 ft. in diameter and 27½ ft. deep having a combined capacity of 280,000 gal. and operate on the radial flow system.

The dry weather flow is 30 G. P. C. or a total of 450,000 gal. All flows above 3x D. W. are diverted.

Four sludge digestion tanks are 22 ft. in diameter and 21 ft. deep with a combined capacity of 32,000 cu. ft. (the figure of 66,812 cu. yd. given in the text is obviously in error). This allows 2.1 cu. ft. per capita on the present population and 1.6 cu. ft. per cap. on the 20,000 design basis. Gas is not collected though sealing rings are provided for installation of gas covers at a later date.

The effluent from the trickling filters is reported to contain 4 parts per 100,000 of nitric nitrogen uniformly.

The Birmingham Plant.—Population 1,100,000; D. W. F. 33,000,000 gal. sedimentation tanks and bacteria beds.

A bioaeration plant for treating from 7.5 to 10 M. G. D. of sedimentation tank effluent is said to provide an effluent which can be applied to the bacteria beds at twice the rate formerly used. An additional 10 M. G. D. unit is in process of construction.

All sludge at the plant is digested and part of the digestion gases collected for power; 550 H. P. being recovered at the time (June, 1929).

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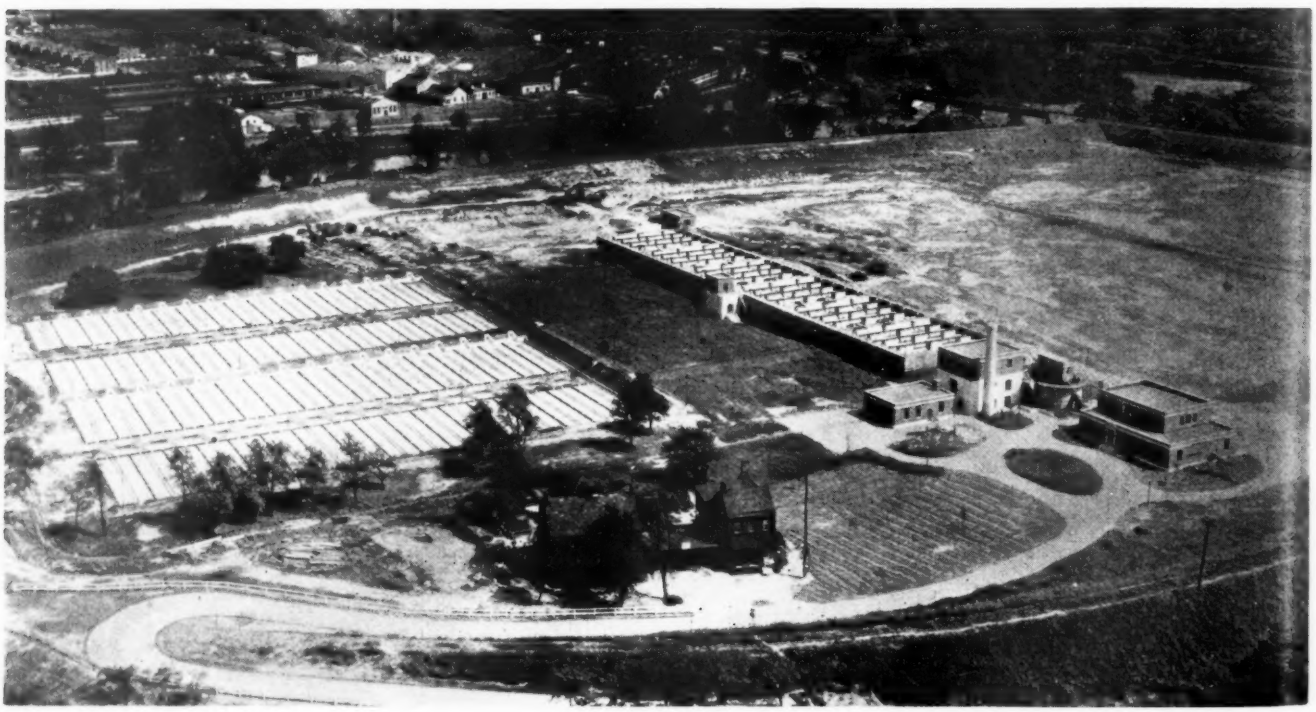
Water Consumption in New York City.—Figures for the first half of 1930, and including also the month of July, show the average daily consumption of water for New York City was 921,700,000 gals., or 65,700,000 ahead of the average daily consumption for the same period in 1929. Last year there were three very warm days in June when the consumption of water ran slightly over 1,000,000,000 gals., but this year an enormous increase in the use of water during the hot weather was shown for July and early in August, when the consumption ran over the billion mark every day, exclusive of Sundays, from July 18 through the first week in August. July 21 of this year set a record here for the amount of water consumed in one day, when 1,200,000,000 gals. were used. Several other days during the very hot spell ran more than 1,100,000,000 gals.



Sewage Treatment Plant of Allentown, Pa., Consisting of Imhoff Tanks and Sludge Drying Beds, with Provisions for Trickling Filters. Designed by Metcalf & Eddy, Consulting Engineers, Boston, Mass.

Zeolite Softening Plant of Sewickley, Penn.

A Description with Operating Results of One of the Pioneer Installations Using Zeolite in Gravity Type of Filter Unit

By D. E. DAVIS
Of The J. N. Chester Engineers, Pittsburgh, Pa.

ABOUT three years ago the first large municipal softening plant using Zeolite was built just below Pittsburgh, using four steel pressure units for enclosing the zeolite. In the design of the new plant at Sewickley, which is about twelve miles below Pittsburgh on the Ohio River, it was decided to employ the open gravity type of softening plant, quite similar in design to the usual gravity filtration plant.

The Raw Water Supply.—The raw water supply is a clear sparkling water which had been used for many years in the community without treatment of any kind, except chlorination. It is taken from a large timber crib which was built on the bottom of the Ohio River and covered over with sand gravel. The water is a true ground water and is as a rule about twice as hard as the river water immediately above. It is usually quite pure, and coli organisms are seldom in evidence. Its hardness averages about 200 p.p.m. of which about a third might be classed as permanent hardness. The water, therefore, might be regarded as offering a fine opportunity for softening with zeolite.

General Features of Plant.—The plant is located in a high class residential community, and special effort was made to give the building a pleasing appearance, since it faces a boulevard which will be heavily traveled. Viewed from the boulevard the building appears as a low brick structure trimmed in stone. The softening plant and laboratory occupying the portion on the right of the main entrance and lobby, and the office and pumping station that on the left. On entering the pumping station a visitor would see a round railing at the top of a deep watertight concrete well. Looking over this railing he would see a spiral stairway around the walls of the circular pit, leading to the floor about 41 ft. below, on which are mounted to motor driven centrifugal pumps (each of 1,400 g.p.m. capacity). These pumps lift the water from the river crib through a pipe line laid in a concrete tunnel and deliver it into a small basin just outside the plant.

On the pump room floor, on which the railing is erected, there are duplicate motor driven pumps, which take the final softened water and pump it to the storage reservoirs on the hills above the borough. There is also a wash pump for back-flushing the softening beds. A hand crane runs over this part of the station and is of considerable help in handling heavy material.

Details of Softening Plant.—The heart of the softening plant is at the other end of the building opposite the pump station and consists of four rectangular concrete beds which have very much the same appearance as the usual type of gravity filter units. In fact, with some modifications, that is exactly what they are. One of the beds contains ordinary filter sand, while the other three beds are equipped with green sand (or zeolite) which is used for softening. If the visitor looked over into one of these beds he would see the clear hard water as it came from the small equalizing basin outside. A few inches below the surface he would see two steel filter troughs running the length of the bed and below that again the sand above mentioned. There is 30 in. of this sand below that 18 in. of graded gravel, the bottom and coarsest part of which is placed immediately around and over the bronze strainers of the umbrella type which perforate the softener bottom on 6 in. centers. Immediately in front of each softener there is a marble table on which are mounted the handles for operating the hydraulic valves controlling the softener units, as well as the gauges, which give a picture of the operating conditions in the softening units.

If the visitor stepped outside the plant he would see a rectangular concrete basin about 16 ft. deep whose top is nearly level with the ground. Looking over the iron railing he would see a clear water (really a saturated brine) with possibly a carload of ordinary granulated salt appearing at the bottom of the tank trough the brine solution. This tank is large enough to hold two carloads of salt. The salt is hauled by dump trucks which simply back up to this basin and dump their load directly into the brine solution. It is an extremely simple and effective storage arrangement, being compact and lending itself to ease of handling. Naturally the salt solution does not freeze.

How the Process Works.—The softening medium is a green sand (called glauconite) which is found in natural state and in very large quantities near the New Jersey coast line. It is washed, sized and treated so that on arriving it is fairly uniform in size (coefficient 1.50) and fairly fine (about .29 mm. effective size), or a little finer than the usual filter sand.

In the case of the Sewickley plant the water passes down through the sand bed and is softened in three of the units whereas in the fourth unit is is merely filtered through. The soft water from the three units is mixed with the hard water from the fourth unit so that the final product has about 65 p.p.m. of hardness remaining, which is regarded as being quite satisfactory since it is less than one-third as hard on the average as the crib water.

The sodium in the green sand is used up after a certain amount of water has passed through the bed and it is then necessary to renew or "regenerate" it. In doing this a definite amount of saturated salt brine is drawn into a concrete chamber in the basement, and then diluted to about a 5 per cent solution. When the operator is ready to regenerate the bed, he pushes a button on the control table, beside the softener, to start up a small centrifugal pump which delivers the brine through perforated pipes over the entire surface of the bed. A small valve is then opened and the brine solution is drawn slowly down through the sand. There is another "switch of partners" and the sodium in the salt now goes into the green sand and the calcium and magnesium is washed out of the bed to the sewer, by passing clear hard water through the bed until the waste material has been removed. The bed is then ready to start all over again, and from all indications there is no wearing out of the sand and the cycle can be continued "forever and two days."

Operating Results.—Since the plant began its operation in February of 1929 up to the end of May, 1930,

its has delivered 424,530,000 gal. of water. The average hardness of the water has been 195.4 p.p.m., and the final product has averaged 65.4 p.p.m. This represents a removal of 130 p.p.m. of hardness, in the doing of which a total of 664 tons of salt have been used; or at the rate of .39 lb. of salt per thousand grains of hardness removed, which may be regarded as a low figure. Tests extending over several months indicate that the sand has a capacity of removing approximately 3900 grains of hardness per cubic foot of the mineral which is also a good performance. This is largely accounted for by the fact that the operating rate and the vertical flow through a constant rectangular cross-section make it possible for every sand grain to work to the maximum efficiency.

The thing which strikes a visitor forcibly is the extreme simplicity of the operation. The entire plant is run by one man per shift, who has ample time to attend to all details without being rushed. The areas of the sand bed and the rate of flow, etc., are held the same as in a filtration plant. This was done with intention, so that if any break should occur in the timber crib, admitting river water, the plant could be converted into a filtration plant within an hour's notice by simply adding alum through the dry feed machine provided for that purpose. Definite schedules are followed, such that the beds are regenerated alternately.

Data on Plant Operation

Date	Pumpage in Mil. Total	Gals. Ave. Daily	Gals. of Wash Water	No. Regen.	Hardness in p.p. m. Raw	Hardness in p.p. m. Final	Approx. Salt in Pounds	Hardness Removed in gr. Per Gal.	Lbs. of Salt per 1000 gr. Removed
1929									
Feb. 13									
Feb. 28	13.22	.825	440,000	68	219	80.8	42,700	8.09	.398
Mar. 31	21.96	.708	260,000	93	184.8	64.8	58,400	7.02	.380
Apr. 30	22.49	.749	220,000	88	165	58.3	55,300	6.23	.396
May 31	22.10	.714	140,000	80	172	61.2	50,200	6.47	.351
June 30	33.35	1.111	120,000	166	209.6	61.1	104,200	8.68	.361
July 31	31.81	1.026	180,000	171	224.4	63.0	107,300	9.44	.357
Aug. 31	35.72	1.151	220,000	204	242	72.7	128,100	9.90	.362
Sept. 30	30.06	1.002	240,000	189	272.5	97.5	118,800	10.24	.386
Oct. 31	25.16	.811	200,000	161	238.0	62.8	101,100	10.25	.394
Nov. 30	29.01	.968	200,000	121	177.3	61.4	76,100	6.77	.388
Dec. 31	27.43	.886	100,000	116	169.5	62.2	72,700	6.28	.422
1930									
Jan. 31	26.79	.864	120,000	97	159.	62.9	69,900	5.62	.406
Feb. 28	24.95	.892	120,000	103	172	62.8	64,500	6.39	.405
Mar. 31	29.75	.958	220,000	117	168.3	62.5	73,300	6.18	.399
Apr. 30	22.91	.764	140,000	88	170.2	60.1	55,300	6.44	.376
May 31	27.82	.898	200,000	135	192	60.6	84,500	7.68	.395
				1997					
Total	424.53		3,120,000	2,800,000			1,253,400		
Ave. 473 days	.898	.898	6,600	1,440	195.4	65.4		7.6	.389

Estimated Distribution of Low Service Pumpage

	Pumpage	Per cent
Rinsing—approx.	31,100,000	6.7
Wash Water	3,120,000	.67
Brine	2,880,000	.62
Pumpage, high service	424,530,000	92.
Estimated low service pumpage	461,630,000	100.00

Unit Costs

Power—per million gallons	$19.20
Wages—per million gallons	11.40
Salt and Hauling	9.85

Acknowledgement.—The foregoing is a paper presented before the Pennsylvania Section of the American Water Works Association.

Model Sewage Works for Mississippi State Sanatorium

Plans and specifications have been prepared for a new sewage treatment plant for the Mississippi State Tuberculosis Sanatorium at Sanatorium, Miss. The sanatorium is under the supervision of the Mississippi State Board of Health, and the Bureau of Sanitary Engineering prepared the plans and specifications and will have charge of the installation.

The present treatment plant consists of a small septic tank and three small sand filters now greatly outgrown. The new plant will consist of a pumping station with duplicate pump installation, Imhoff tank, twin dosing tank for common nozzle field trickling filter, and resedimentation tank. Chlorinators will be provided to chlorinate raw sewage entering the pump pit and the filter effluent entering the resedimentation tank. Discharge will be into a small running creek. The existing septic tank will be utilized as the resedimentation tank and the existing sand filters will be converted into sludge drying beds.

The present normal dry-weather flow of sewage amounts to 200 g.p.m.; the maximum hourly flow is 313 g.p.m. The plan is designed for a 16 per cent increase over the present flow. The cost will be approximately $35,000.

It is intended to make this a model plant and equip it to serve as an experimental ground for the Bureau of Sanitary Engineering and a demonstration to municipal officials confronted with sewage treatment problems who might be interested in this type of plant.

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Water Consumption Records Broken in St. Louis.—All records for water consumption in St. Louis during a single month were broken during the heat-ridden July. During the 31 days, on many of which the mercury soared over 100, the city water department pumped 5,052,651,910 gals. of water. This is an increase of 726,722,630 gals., or approximately 17 per cent, over last year, when 4,325,929,280 gals. were pumped.

Laboratory Control of Filter Plants

The Problems of the Purification of a Water Supply for Thousands of People Are Complex and Cannot Be Solved in a Rule-of-Thumb Manner

By A. C. JANZIG

Bacteriologist and Chemist, Columbia Heights Filtration Plant, Minneapolis, Minn.

WHEN no preliminary analytical survey of the raw water is conducted before the plant is put into operation, the first concern of the plant operator is to ascertain the bacterial and chemical characteristics of the raw water employed.

Some of the questions which will naturally arise are: What are the physical and chemical constituents of the water? What is the bacterial load of raw water, and are there large numbers of the B. coli group present? What is the biological nature of the water to be treated?

Each Supply a Separate Study.—Contrary to popular belief, not all raw waters have the same characteristics and will not respond to the same treatment, but each raw water supply becomes a separate study in itself. For instance, there are certain highly colored waters which will yield to coagulation and color removal with alum, while for other waters it has been found more effective to use lime and iron, chlorinated copperas, or sodium aluminate as coagulants. By experimentation with color reduction tests and alkalinity and hydrogen-ion determination, the water analyst soon recognizes the most efficient coagulant to use. The economic control in the use of coagulants is seen to be a very important item when one considers the large sums of money spent annually for the removal of color and turbidity.

Frequent color readings are important, as the slightest change, i. e., one part per million or more of color, can be detected by the trained analyst. This apparently trifle change in color may make a difference in chemical treatment of from $5.00 to $10.00 per day where large volumes of water are treated. Armstrong (1) at Omaha, Neb., reported that laboratory supervision saved the city $9,000 per year.

Color Removal.—Where the color is to be removed from a raw water, the intensity and the time in mixing the coagulants are important factors. Laboratory experiments have pointed out that at certain seasons of the year a lengthy mix of chemicals may be detrimental to good "floc" formation. As an example of this point, it was found by laboratory observations at one of the Minneapolis filter plants that a better color removal could be obtained if several baffles were removed from the mixing chamber. In this particular case, determinations of color, "floc" formation, and rate of settling were used as guides in establishing the proper amount of mixing required.

Another point of importance is the detention period in which the water is allowed to remain in the coagulating basins. The laboratory is again called upon to say whether a minimum of 2 or a maximum of 5 hours of contact is desired, so that an economy of coagulant may result. Valuable detention period data can be secured by making observations of "floc" formation and the rate of settling of suspended matter at different points in the coagulating basin.

In some cases poor coagulation, as determined by color removal and bacterial reduction, may be caused by an over as well as an under dose of coagulant. The control of coagulation at the optimum point results in a better filter effluent, as well as a maximum efficiency with a minimum amount of chemicals. For checking the amount of applied alum to a coagulated water, the alkalinity determinations are valuable tests, as the alkalinity reduction is proportional to the amount of alum added. The introduction of hydrogen-ion determinations has made it possible to control the pH (acid and alkaline character) of a water, so that the chemical reactions will go to completion.

Study Required of Individual Filter Units.—The individual filter units will require study so that they will produce an effluent of low bacterial count and free from suspended matter. Routine samples taken from the effluents of each filter unit and tested for the presence of turbidity and color will, in some instances, furnish a better guide for washing filters than the customary dependence on "loss-of-head." A fruitful field for research may be found in determining the physical and bacterial loads permissible for rapid sand filters. A periodic examination of the filter sand will indicate the "effective size" and the nature of the material adhering to the surface of the sand grains. The coatings of some sand grains have been found by chemical analysis to consist of insoluble manganese, which in this condition would be of no consequence; but when conditions become favorable, as occurred at the Columbia Heights filtration plant (2), this element redissolves and becomes a problem. In this case some of the idle filters which were again put into service delivered a high percentage of soluble manganese, extending in some instances for two to three days.

Producing Non-Corrosive Water.—Another important problem from the standpoint of boiler-water is the production of a non-corrosive water. In many cases it is necessary to decrease the hydrogen-ion concentration after filtration by treating the water with lime, soda ash, or some other alkali. By making pH determinations and by titrating for the carbon dioxide content, one can regulate the reaction of the water to the point where the smallest amount of corrosion will take place with a minimum dosage of alkali. Dissolved oxygen determinations of a water will in many cases indicate whether the oxygen concentration is a factor in the process of corrosion. An example of what can be done with a corrosive water is reported by Williams (3) of the West Palm Beach Water Company where "red water" trouble was remedied by a careful chemical control. He found that a water having a carbon dioxide content varying between 2 and 6 parts per million and with a pH between 6.2 and 6.8 was sufficient to cause severe corrosion in the distribution system. The presence of 9 parts per million of dissolved oxygen rendered this carbon dioxide highly aggressive.

In cases where the total hardness of a water is exceptionally high, filter plants are equipped to soften as well as purify the water supply. The removal of calcium and magnesium eliminates soap waste and boiler scale and in many cases leaves the water in a non-corrosive condition. Routine hardness, alkalinity, and hydrogen-ion tests will give the operating data neces-

sary to carry the softening process to an efficient completion and to maintain the proper chemical balance.

Taste and Odor Removal.—The production of a water free from tastes and odors has become a perplexing problem for some filter plants. The disappearance of dissolved oxygen in a raw water and the presence of large quantities of organic matter and traces of phenol compounds are indicative of approaching trouble. To remedy a condition of this kind intensive laboratory research must be carried out by testing the effectiveness of methods such as aeration, excess lime treatment, prechlorination, ammonia-chlorine treatment, and filtration with activated carbon.

The final treatment of a coagulated and filtered water, which is sometimes referred to as sterilization, is accomplished in most plants by the use of chlorine. The proper chlorine dosage is determined by correlating data of the chlorine capacity of the water and by residual chlorine tests and bacteriological examinations. The chlorine consuming power of waters varies greatly, so that this phase of the purification process requires intensive study.

The safe-guarding of a water-supply can be accomplished intelligently only by routine bacteriological analyses. The organisms belonging to the B. coli-aerogenes group are the recognized indices of pollution and their determination should be standard practice at all filter plants. This is the only practical means known to sanitary science by which the possible presence of water-borne disease-producing organisms can be indicated.

Therefore in conclusion, the control of a filter plant should include physical and chemical determinations, qualitative and quantitative bacterial examinations and periodic plankton counts. By these routine tests applied through the various stages in the purification process, a filter plant will be placed on an efficient operating basis. The purification of a water-supply for thousands of people cannot be effected by a rule-of-thumb manner, as the problems are complex and it is desirable to obtain the utmost in economy and efficiency.

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Acknowledgment—The foregoing is an abstract of a paper presented before the Minnesota Section of the American Water Works Association.

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New Automatic Equipment Speeds Water Service

A new piece of automotive equipment which speeds up service more than 75 per cent in some classes of maintenance work and is proving its merit especially as a one-man emergency machine has been developed by the Hackensack Water Co., Weehawken, N. J.

The equipment, attached to a 1¼-ton truck, has been under test for the last 14 months in the company's daily work. It has been assembled by George F. Weighardt, hydraulic engineer in charge of distribution over the 800 miles of mains in the company's system. It consists of pumps, gears for opening and closing main valves, and emergency appliances, and is actually a composite of several pieces of service machinery required in water utility work.

The truck in some respects resembles a police patrol car. Attached to the running board on the left side, and connected with the motor, is a gear which can be fitted in a few minutes to main valves which require opening or closing. Under the front end of the radiator is a hose connection attached to a pump which is also operated by the motor.

Opening or closing large valves is ordinarily one of the most laborious operations which a water company crew encounters, A 36-in. valve requires about 250 turns and under the usual system a crew of six or eight men, grasping a bar locked to the top of the valve, walk around in a circle. The whole operation of opening and closing one of these valves formerly occupied from three to four hours exclusive of any repair work.

When a valve job now occurs in any part of the company's system, the new truck is dispatched with a crew of two men. The gear on the running board is brought over the valve, dropped and locked to it. The driver then starts the motor and the number of turns imparted to the valve appears on a gauge set in the instrument board. Even working at slow speed, the truck mechanism can open or close a 3-ft. valve in 30 minutes and with less strain on the metal.

The pump attached to the motor is equally efficient. Confronted with a flooded excavation or manhole, the truck crew attach a section of hose to the pump connection and start the motor. A pull of 300 gal. per minute can be exerted by the truck's engine. A large portable searchlight makes it possible for the truck crew to work under any conditions of darkness.

Enclosed in boxes mounted on the sides of the truck are extra hose sections, tools, repair parts and clothing for crews. Even a full set of maps showing the location of every valve in the company system is part of the equipment, making unnecessary any reference to office records, even by telephone.

When loaded with its maximum complement of tools and emergency materials, the new truck weighs about 3 tons. Standard crew is three men and a driver, but every operation can be performed by the driver and one man.

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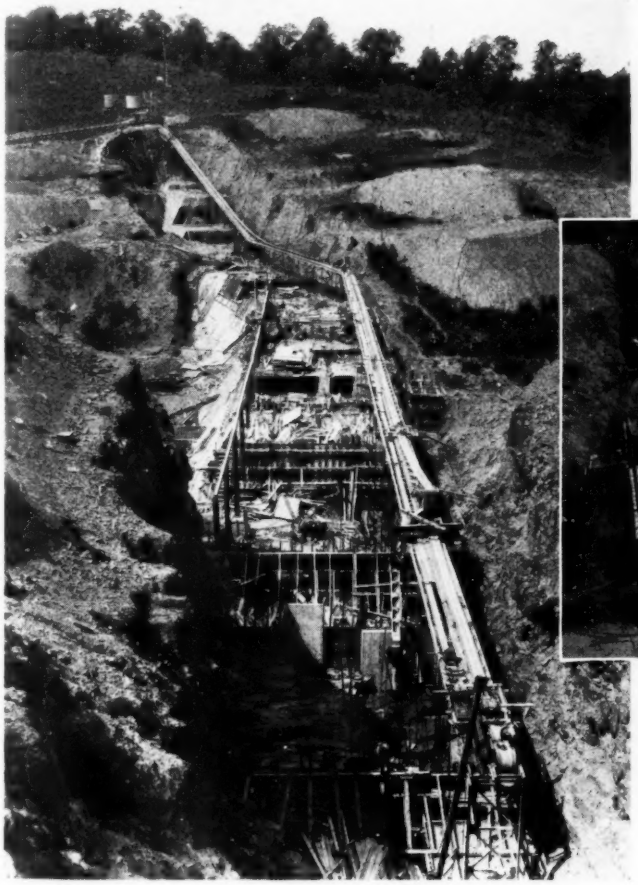
New York City Has City Planning Department

New York City now has a Department of City Planning, the law creating this department becoming effective on Sept. 1. Major John F. Sullivan has been appointed the City Planning Commissioner, He will construct a topographical model of the city which will show existing and authorized streets, highways, street grades, public places, bridges and tunnels, and in fact all the other features of the physical make-up of the city. He will also prepare a master plan of the city, which, in addition to showing the existing physical status, will also serve as a guide or central plan for future city improvements. The Department of City Planning is to act as a co-ordinating agency for projects under consideration by the various city departments. The commissioner can recommend, but cannot force the adoption of his suggestions or decisions. His powers are only advisory. He will, however, make preliminary recommendations on all plans or projects for major improvements relating to or affecting the master plan previous to their presentation to the Board of Estimate and Apportionment. He will also report on proposed changes in the present map or plan of the city.

The Belt Conveyor in Dam Construction

The Central Mixing Plant and Conveyor No. 1



Junction of Conveyors No. 1 and No. 2 and No. 3 Tank

AN interesting layout of belt conveyors in being employed in the construction of the Old Mill Stream Dam of the additional water supply development of the City of Wilmington, Del. The gravity section type concrete dam will be approximately 1000 ft. across the crest with a base thickness of about 90 ft. and a thickness at crest of 16 ft.

The concrete is mixed in a central mixing plant and spread on conveyor No. 1—a 24-in. belt running up the side hill at an angle of approximately 15° and for a distance of about 850 ft. The concrete is transferred to conveyer No. 2 which carries it for a distance of about 360 ft. It is then transferred to conveyor No. 3 which continues across the dam. In the lower part of the valley, where the dam has the greatest crosssectional area, the concrete is transferred to a belt on a gantry crane, and is placed by counter-balanced chutes.

Conveyor No. 3, Gantry Crane and Placing Chutes

Upstream Face of Dam on Sept. 4. Some 70 ft. in Height Was to Be Added

Necessary Tests at Small Filtration Plants

Simple Tests That Can Be Run by the Smallest Plant and the Inexperienced Operator Who Has Little or No Chemical Training

By J. M. JESTER

Assistant Engineer, Washington Suburban Sanitary District, Hyattsville, Md.

OPERATORS of small water filtration plants frefrequently fail to recognize the importance of making certain daily tests as well as recording their results. Some may consider these tests too difficult, while others may not run them for lack of interest. As a rule, the necessary tests may be run at the small filtration plant without a great deal of effort. A copy of "Water Purification Plants and Their Operation," by Stein, and "Standard Methods of Water Analysis," by the American Public Health Association, will be found helpful to the operator.

The water supplied a community should be safe from a bacteriological standpoint and of acceptable physical quality. These requirements can be effected only through the frequent running of routine tests. The results of the tests, if recorded, will be valuable in establishing the purity of a water for weeks previously, in the event of a typhoid epidemic, as well as an aid in eliminating many operating difficulties. A comparison of records from time to time will help in obtaining better plant efficiency, and if the records are placed in the proper authorities' hands they may aid operators of other plants, should they have difficulty with unusual operating conditions.

Sampling.—In order to obtain accurate results from tests, care should be taken in the collection of samples for testing. Carelessness in gathering specimens is not only a waste of time, but misleading in the results obtained. When taking samples for chemical analysis, glass stoppered bottles free from alkalies and acids should be used. The bottles should be rinsed several times in the water to be tested before actually collecting the specimens. When taking a sample from a stream, the bottle should be filled by a slow motion away from the body, in order to prevent the water from coming in contact with the hand before entering the bottle.

Turbidity.—Next to the proper sterilization of a water supply, the elimination of turbidity is of prime importance. The efficiency of the whole filtration process depends largely upon the continuous removal of turbidity from the raw water. The operator of a filtration plant should know at all times both the degree and character of the turbidity in the raw water entering the plant and the completeness of turbidity removal in the filtered water. Turbidity, as to character, is gauged by its coarseness or fineness. This condition will depend to a large extent upon the geological nature of the water-shed. A knowledge of the raw water turbidity is necessary at all times in order to determine the proper amounts of coagulants to be applied. When difficulty is experienced in obtaining a satisfactory floc with a fine turbidity or after a sudden thaw, jar tests will be found to be of much practical value in determining the amount and combination of coagulants to obtain the best floc. I recall several years ago when difficulty was experienced in treating a raw water with a turbidity of several hundred p.p.m., following a sudden thaw, a sample of the water was taken and a jar test run. Very little floc was obtained with a straight alum treatment, regardless of the dosage. A better floc was obtained by the addition of soda ash, and a satisfactory floc by the combination of alum, lime and soda ash. The proper dosage known, this combination was applied on a plant scale with satisfactory effluents resulting. Jar tests require but little time and the results obtained, both in satisfactory effluents and a probable saving in chemicals, are well worth the effort.

While a high raw water turbidity does not always indicate a high state of pollution and filter effluents having a turbidity of 5 p.p.m. or thereabouts may not cause complaint from the consumer, the lower the effluent turbidity is kept, the lower the residual chlorine may be dropped to insure sterile water.

For the reading of turbidities ranging from 5 to 100 p.p.m., the bottle type turbidity standard is generally used, while with turbidities above 100 p.p.m. the candle type tubidimeter is more satisfactory. With the bottle type standards, the bottle used for collecting the samples should be of the same make as those which contain the standard solutions. If the operator permits this bottle to become coated on the inside, incorrect readings will result, especially with turbidities ranging between 50 and 100 p.p.m. With the candle type turbidimeter care should be taken to keep the flat bottom of the graduated tube free from sediment.

In determining the turbidity of effluents, the Baylis type turbidimeter is recommended. This turbidimeter has a range of 0.1 to 2 p.p.m. and will aid materially in keeping the turbidity of the effluents at a minimum. Prior to the use of this type of turbidimeter at the Burnt Mills Station of the Washington Suburban Sanitary District, a residual chlorine figure of 0.28 to 0.35 p.p.m. was necessary for satisfactory bacterial results, but since its use better effluents have been maintained and satisfactory results obtained with residual chlorine ranging from 0.14 to 0.35 p.p.m.

Hydrogen-ion Concentration.—Hydrogen-ion concentration, more frequently termed pH, is based upon the magnetic attraction of positively and negatively charged ions of which the water is composed, and is used to determine to what degree a water is acid or alkaline.

There are several methods which may be employed to determine the various pH values of water, but for general purposes the colorimetric method seems the most satisfactory. This method employs the use of a standard color indicator and a set of color standards. The color of the indicator to be used, as well as the range of the color standards, depends upon the acidity or alkalinity of the water to be tested. Color standards should be kept in a dark place, when not in use and away from the sunlight as much as possible, to prevent fading. The standards should be checked for accuracy at least once a year.

In making pH determinations the hands should be clean and free from acids or alkalies, as a very small amount of either coming in contact with the water to be tested will result in incorrect readings.

Hydrogen-ion determinations, both in the raw and filtered water, are highly important in the daily opera-

tion of the filtration plant. Waters have varying degrees of acidity or alkalinity, and a maximum precipitation of impurities will take place at a certain pH, which is termed the optimum point. The optimum point for a given water may be obtained by running a series of jar tests with various turbidities and under differing operating conditions. A curve plotted from the results of these tests will aid materially in obtaining satisfactory coagulation during unusual operating conditions. Should the pH value of the raw water be below the optimum point, alkalies are added in obtaining a good floc, or should the reading be higher than the optimum point, more alum is required where alum is used for a coagulant. The pH control on raw water will prove exceedingly helpful in controlling chemical dosages and obtaining satisfactory coagulation.

Alkaline water is highly desirable in the distribution system, as acid waters are likely to cause complaint and criticism. The most frequent complaint heard is that of red water. This is due to an acid water attacking the plumbing and the reaction which takes place when the acid water is heated in the hot water tank. There is no doubt in the writer's mind but that red water troubles could be practically eliminated if the proper pH in the filtered water were maintained at the filtration plant. Aside from red water troubles, an acid water will cause galvanized piping in house connections and plumbing to corrode to such an extent that it may have to be completely renewed in a comparatively short time. Also, the carrying capacity of the water mains will decrease.

As previously stated, an alkaline water is desirable but it should be borne in mind that if the pH value be kept too high the water will be hard and not palatable, which may also result in complaints. Hourly determination of filtered water pH will result in water of uniform alkalinity being delivered the consumer.

Hardness.—Hardness, usually caused by calcium and magnesia, is expressed in terms of calcium carbonate. The calcium carbonate equivalent of calcium and magnesium content, sometimes with iron and aluminum, is a measure of total hardness in a water. The soap method of determining total hardness, though giving only approximate results, is usually satisfactory for the small plant. With this method a standard soap solution is used to titrate 50 c.c. of the sample in a 250 c.c. glass-stoppered bottle until a permanent lather is obtained. The amount of soap solution required being known, the total hardness in p.p.m. may be found by referring to Table No. 5 in "Standard Methods of Water Analysis."

The amount of total hardness a water may have, without causing complaint regarding taste and suitability for washing purposes, depends upon the locality being served. Some communities are supplied a water having a total hardness of 100 or 200 p.p.m. There is no complaint because the populace is accustomed to a hard water. However, a water having a total hardness of not more than from 25 to 35 p.p.m. is desirable.

Hard water is objectionable to large consumers using tubular boilers, due to the incrustation which forms on the boiler tubes, causing a higher fuel consumption and the necessity of more frequent cleaning of the tubes.

Tests for total hardness should be made on the raw water and filtered water at least once each day.

Residual Chlorine.—Tests for residual chlorine should be frequent enough for the operator to know at all times the amount present in the filtered water. The most usual method for determining residual chlorine is with ortho-tolidine. This method consists of a standard ortho-tolidine solution with permanent color standards. For the small plant it is most convenient and accurate to buy this type of outfit from a reliable firm selling such supplies.

The amount of available chlorine required to sterilize a water depends upon the amount of organic matter present in the water. The lower the effluent turbidity and the lower the amount of organic matter present, the smaller quantity of chlorine needed for sterilization. As fluctuations in water temperature, organic matter and water delivery affect the amount of chlorine required, it is advisable to make a residual test once each hour or so. In this way accurate control may be maintained. Should the effluents become turbid, bacteriological results show positive, or any other unusual conditions occur, however, the chlorine dose should be immediately increased sufficiently to take care of the existing condition.

It is desirable to run the residual chlorine as low as possible, consistent with safety, because of its tendency to aggravate and produce objectionable tastes and odors. Popular complaint on this score, though annoying, is of secondary importance to sterility.

Taste and Odors.—The waters from most streams, suitable for use as sources of public water supply, do not possess, under ordinary conditions, seriously objectionable tastes or odors, except where there are industrial plants emptying wastes above the supply intake. There are periods, however, when tastes and odors in the waters of streams, generally speaking, are objectionable. These are usually after a heavy rain or thaw. The frequent testing for tastes and odors will result in a quicker detection of objectionable conditions, and if their removal is possible and prompt, this action may save considerable criticism from consumers.

For testing odors in cold water, approximately 250 c.c. of the samples are placed in a 500 c.c. bottle and shaken well. The bottle is then allowed to stand until the water has reached approximately the temperature of the room, whereupon the stopper is removed and the odor noted. For testing odors in hot water, approximately 150 c.c. of the samples are placed in a 500 c.c. Erlenmyer flask, covered with a tight fitting watch glass, and heated. Just before the boiling point is reached, the water is agitated by a revolving motion of the flask, the watch glass removed, and the odor noted.

A comparison of the results obtained from these tests following turbidity changes, thaws, etc., may be of much value in determining the cause of certain objectionable tastes and odors. The results of taste and odor should be recorded to agree with the designations for quality and strength given by the "Standard Methods of Water Analysis."

Conclusion.—The above mentioned determinations can be made by any operator if he is interested in the proper control of his plant. Frequent observations are necessary if the results are to be of real value. Such procedure will give the operator a better understanding of the principles involved in water purification, the causes of operating troubles, and the methods to be employed in eliminating such difficulties.

Acknowledgment—The foregoing is a paper presented at the 4th annual conference of the Maryland Water and Sewerage Association.

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WATER WORKS PAY ALL CITY EXPENSES.—For the third successive year the city council of Colby, Kan., voted to let the municipal water plant pay the city's bills. During two years earnings of the plant has paid administration bills, provided for pavements, paid for new equipment and placed a balance of $45,000 in the city treasury.

The Reforestation of Public Water Supply Watersheds

The Developments in Eastern States and a Discussion of the Parallel Uses Which Are Being Made of Watersheds Aside from the Protection and Improvement of Water Supply, Including Such Possibilities as Practice of Forestry, Landscape Improvement and Recreational Use

By JAMES O. HAZARD
Assistant Forester, Virginia Forest Service

THE reforestation of open lands on public water supply watersheds is of quite recent development in this country. A few notable beginnings were made as much as 30 years ago, substantial increases are recorded as of 20 years ago, but the most extensive plantings are of the past 10 years. It is difficult to say whether this development has come as a result of the increase in public interest in reforestation or as a result of the ever increasing demands of our communities for that high type of water supply which can usually be secured best from properly managed forested catchment areas. It is noteworthy that increase in watershed reforestation closely parallels the increase in the educational and direct service activities of our state forestry departments. Some water companies have doubtless been interested in reforesting their watersheds from the point of view of putting idle lands into use, but it is certain that many water companies have been obliged to reforest parts of their catchment areas, particularly those adjacent to their streams and reservoirs, in order to prevent the harmful silting up of the same. While grass sod will prevent soil erosion in some cases, it is more expensive to maintain than forest cover and is less effective under average conditions.

Benefit of Forest Covers for Watersheds.—Common human experience in observing the performance of springs, streams and lakes, with and without protective forest cover, and scientific data secured by painstaking experiment and research, agree that forest cover provides the best type of protection to watersheds. It has been scientifically proven by studies made in Europe and America that forests

(a) Increase local precipitation;
(b) Stabilize the flows of springs and streams;
(c) Decrease the waste of water through excessive run-off such as usually occurs in their absence;
(d) Temper the climate;
(e) Effectively prevent erosion with its accompanying costly waste of soil and silting of streams and reservoirs.

All of these beneficial influences become active as soon as a forest cover is established and remain so until it is destroyed. In the planting of forests it has been found that many species will provide a complete ground cover in from seven to ten years. While the beneficial effects of a young forest are not as great as those of a mature forest, substantial benefits to watersheds have been noted from planted forests not more than ten years old.

What Has Been Accomplished in Watershed Reforestation.—The fact that forest cover for watersheds is regarded as ideal by both scientists and laymen is probably responsible for the substantial progress that has been made in recent years in the reforestation of the open lands of many important public water supply watersheds. To give you some indication of the extent of the watershed reforestation that has been accomplished within the past 30 years, I will summarize such information as I have, covering this activity in a number of our eastern states. This information has been obtained in part from state forestry departments and in part from water companies themselves.

In Massachusetts, 2,663,000 trees have been planted in 86 town forests, nineteen of which are used as watersheds.

In Connecticut, 20 cities and towns or other political districts own watershed protection forests having a total area of approximately 23,000 acres, 13,000 acres of which is more or less wooded naturally and 1,000 acres of which have been reforested by the planting of approximately 1,200,000 trees. Three private water companies owning about 40,000 acres have planted about 4,357,000 trees.

In New York State two-thirds of the cities have planted forests around their sources of water supply. Twelve of these have planted 10,224,400 trees, mostly on watersheds. In many cases this reforestation is a result of programs extending over a period of from 15 to 30 years.

In New Jersey, 15 municipalities and private water companies are actively reforesting their watersheds.

In Pennsylvania the Department of Forests and Waters makes the following statement which is indicative of the situation within that state. "Since 1910 . . . 122 water companies have planted a total of 10,000,000 trees (secured from the state nurseries) on their watersheds. Several million additional trees purchased from private nurseries were also planted. Pennsylvania's reforestation program is a very helpful factor in conserving supplies of potable waters needed by the people and the industries of the state."

These brief statements clearly indicate that forest cover is rapidly being provided for watershed protection purposes throughout the northeastern states. Additional correspondence which I have had with many of these water companies indicates that a large majority of them definitely plan to completely reforest all idle open areas within their watersheds. Among those who are committed to such programs are a number of the largest and most successful public water supply agencies.

Reforestation Work of York Water Co.—It is interesting to consider the initial causes which have led some of these water companies to embark upon reforestation. In this regard the case of the York Water Co., of York, Penna., is worthy of discussion. In a very attractive booklet entitled "York's Water Works," the general manager of the company, Mr. Edgar P. Kable, gives the following very interesting description of the company's reforestation work. He writes as follows under the heading "Reforestation":

"After the dam was filled another problem presented itself, that of preventing erosion of the soil from the

slopes surrounding the basin. The planting of the slopes with grass was suggested. The planting of trees was also suggested and after consulting prominent authorities on picturesque planting, Professor J. W. Toumey, Director of Yale Forest School, was consulted, outlined a comprehensive program and was very reluctant to take any compensation for his services. Professor Toumey is consulted almost annually and takes a great pride in the success of the planting. The wooded tracts were allowed to remain, except that all chestnut and softwoods were cut down, and where the tracts of deciduous trees reached the flow lines a border of Norway spruce was planted to check the leaves from entering the basin.

In 1913, 50,000 white pines and 5,000 Norway spruce three year transplants were set out, followed by 113,000, 100,000 and 325,000 evergreens in the succeeding three years, and as additional tracts were purchased they were planted in the same manner until today there are planted on the tract over six hundred thirty thousand evergreens which are in a most flourishing condition.

On Jan. 8, 1925, Dr. C. A. Schenck of Darmstadt, Germany, at one time Director of the Biltmore Forest School of Biltmore, North Carolina, and a forester of international reputation, visited the tract and made the statement that it was the best example of reforesting of evergreens in the world.

The trees are inspected several times annually by the State Department of Forests and Waters, and the White Pine Weevil and Sun Scald, neither of which was serious, were the only ailments found, but the hazard causing the most concern is that of fire. Two fires occurred, one in 1915, caused by the caretaker burning brush, which spread over about one acre of European Larch trees planted the previous summer, and the other in 1925 when a State Department of Highway workman was burning brush along the Susquehanna Trail. This spread over four acres of Red Pines about three feet high. The State made satisfactory settlement for this loss. Numerous fire fighting tools, including rakes, axes and liquid and dry chemical extinguishers, are kept for instant use and the local fire wardens are within call at all hours. The fire department of the village of Jacobus is also suject to call."

Forested Watersheds as Revenue Producers.—Forested watersheds, aside from protecting the water supplies, can be kept attractive and made revenue-producing by the practice of forestry. The character of the original York watershed, which was mostly open farm land before it was converted to its present use, has naturally precluded, so far, the need for other forestry than the reforestation which has just been described. Later wood products can be removed advantageously. Probably there are many other watersheds in Pennsylvania and New York where the forestry so far has been confined almost entirely to reforestation, as at York. Many New York State watersheds now contain more than 500 acres of planted forest, four have more than 1,000 acres and New York City has reforested 2,500 acres. Many of these watershed forests can now or will be able later to do far more than to merely protect and improve the water supply.

The use of these properties for the practice of forestry offers the water company or department many opportunities to secure regular continuing incomes which can be made to more than support the ordinary carrying charges of the forest and at the same time will permit of the development of pleasing landscapes of a type which will increase the intrinsic value of the property.

Reforestation Work of New Haven Water Co.—It is significant that the practice of forestry has already become an acknowledged objective, secondary, of course, to water production, in the program of at least one large and successful water company. As an example of this type of watershed use, the work of the New Haven Water Co., of Connecticut, which owns approximately 20,000 acres of watersheds, is outstanding. This company's attention was focused upon forestry nearly 30 years ago, since which time it has consistently adhered to a policy which has tended to improve its forests through this activity, and at the same time has provided substantial financial returns from a majority of its woods operations. The company plans to continue to utilize forestry as the best means of caring for its watershed. It is now engaged in developing its forests so as to make them normally productive of the best kinds of forest growth. A statement of a part of the management policy of this company is of interest and is here quoted:

The New Haven Water Co., first in acquiring land and later in building up the Eli Whitney Forest to its present size, was actuated by the desire to secure the highest type of natural protection for the watersheds and reservoirs. A well-stocked forest is unexcelled in furnishing this protection. Consequently, the company's policy has been to establish such a forest on open areas and to maintain and improve in quality the existing forest.

. . . the commercial development and operation of a forest is not inconsistent with its functioning as a protection forest. In this particular region the two purposes, protection and commercial profit, can safely be combined. Hence, the policy adopted by the New Haven Water Co., while developing an excellent protection forest, aims to conduct the work so that wood and timber may be sold and the operations made profitable. As a further objective the creation and maintenance of pleasing landscapes is attempted. This purpose also does not need to be in conflict with commercial use.

The popular idea sometimes encountered, that all cutting of trees in the forest must be prevented if good protection and pleasing landscape effects are to be secured, is erroneous. Cutting of trees is the most effective tool which the forest manager has at his command, not only for securing a steady supply of timber, but also for developing and maintaining satisfactory forest landscapes and the best protection forest."

The above statement of the policy of the New Haven Water Co. has been published in an attractive booklet describing its watershed activities. Correspondence with this company and about twenty-five other companies in Connecticut and Pennsylvania definitely indicates that these companies have decided to reforest nearly or quite all of their open lands and have made definite plans to do so. The attitude of these companies undoubtedly reflects the attitude of a majority of the water companies in the northeastern states.

In addition to their power to yield satisfactory revenues from the practice of forestry, selected areas from these forested watersheds can well be used for public recreational purposes without detriment to the quality of the water supplies and with many advantages to the local populations. Outdoor recreation in forest areas can be provided at a minimum of expense as compared with its cost in highly specialized municipal parks.

Acknowledgment.—The foregoing is an abstract of a paper presented at the second annual conference of the Virginia Water and Sewage Works Association.

EDITORIALS

The 7-Year Rain-Cycle and Its Cause

IN the "Monthly Weather Review" of October, 1920, H. W. Clough says: "It is evident that while the 11-year period is that most prominently disclosed in the variations in terrestrial phenomena, a shorter (7-yr.) variation exists which obscures or masks at times the 11-year period." He gives a table of maxima and minima temperatures from a peak in 1792 to one in 1916. We note that 11 of the 19 peaks there given fall within a year of a theoretically perfect cycle of 7 years, if the year 1917 be called a peak year. By the binomial formula of probability there is but 1 chance in 13 that this correlation is accidental.

Clough speaks of the fact that Douglass found frequent evidence of a 7-year cycle in the radial growth of Arizona pines. Clough does not mention that Sir Arthur Schuster, by the periodogram method found a sunspot cycle of 7 years, as well as one of nearly 7.5 years.

In the "Monthly Weather Review," July, 1922, H. L. Moore pointed out what he believed to be an 8-year cycle in rainfall in America. In his smoothed curve of rainfall from 1882 to 1920 there is evidence of 5 cycles of about 8 years. However, this is too few a number to establish the length of such a cycle with accuracy. The editor has found a 7.5 year rain cycle that fits Moore's curve very well. Ater ("Monthly Weather Review," February, 1926, p. 50), by using the Schuster periodogram method, has found a rainfall cycle of about 7.5 years in eastern United States. It happens that during the 40 year period investigated by Moore, the peaks of the 7-year and 7.5-year cycle were not far apart.

The editor has found that the 7-year cycle is due to a coincident maximum effect of the earth's two great magnetic fields and that the 7.523 year cycle is similarly due to Mars. In a later article both of these cycles will be discussed at length, so the present article will be confined to a brief announcement of the three weather cycles caused by the positions of the earth's magnetic axis.

By assuming that the poles of the magnetic axis of the earth's Heaviside layer of electrons rotate clockwise around the earth's axial poles, it can be shown that the earth should produce a sunspot cycle oftener than every 12 months. Using the cyclogram method, which is much more reliable than the inspection of a smoothed sunspot curve, the editor has found a sunspot cycle of 10.5 months. A rainfall cycle of the same length discloses itself clearly in the rainfall of Sitka, Alaska, as far back as 1847, or shortly after those monthly rainfall records begin. Also the same rainfall records disclose a subcycle of $1/3 \times 10.5 = 3.5$ months. This subcycle is evidently due to three permanent electron whirls whose axes are about 120 deg. apart in longitude.

A cyclogram of the annual growth (radial) of the Arizona pines from 1462 to 1906 was made, and it disclosed the 7-year cycle very clearly. A probability calculation shows that the odds are more than 2,200 to 1 against this being an accident. A similar periodogram of the annual growth of the California redwoods from the birth of Christ to 1909 also shows the 7-year cycle, although its peaks are not so pronounced as in the Arizona pines. Apparently these sequoias dropped two annual rings that were not accounted for by Douglass, for during several hundred of the earlier years the 7-year peaks occurred 2 years later than they would have occurred had 2 rings not been dropped. These tree cyclograms completely establish the 7-year rain cycle.

In two previous articles the editor established the 11.2-year rainfall cycle by means of the sequoias and the Arizona pines, going back for more than 3,000 years in the case of the sequoias.

The rainpeaks of the 7-year cycle usually have been greater than the 11.2-year cycle peaks in the regions thus far investigated by the editor. The next 7-year cycle peak will be in October, 1931, but its effects are usually quite noticeable for about a year before and after the peak. Since a peak of the 7.523-year Mars supercycle is due in November, 1930, the combined effects of these two rain peaks should make the next 15 months abnormally wet in the northern hemisphere.

Should the Hoover Dam Be Built Now?

MONTHS ago we urged the appointment of several independent consulting engineers to investigate all the practicable sources of water supply for Los Angeles. Judging by the reports thus far made public it has seemed to us that this great water problem has not received adequate engineering study. We have been strengthened in this opinion by a recent report by La Rue and Jakobsen, consulting engineers, to the Eaton Land and Cattle Co. That company claims ownership of 12,000 acres of land and 51,600 annual acre-feet of water in Long Valley above Owens Valley, California. The city of Los Angeles is about to build a $750,000 dam at the mouth of Long Valley. La Rue and Jakobsen state that by building a higher dam at a cost of $1,200,000, not only can the 51,600 acre-feet be stored, but an additional 51,000 acre-feet of flood waters can be captured. This proposed higher dam, it is said, can not be built under the city's present easement, and the purchase of the Eaton acreage is recommended so that it can be built. These 12,000 acres are offered to the city for $2,300,000. Eaton contrasts the $2,800,000 expenditure needed to secure the additional 51,600 annual acre-feet with the city's proposed $12,556,000 expenditure to secure 98,000 acre-feet in Mono Basin (to the north of Long Valley).

While we have no detailed knowledge of either as to the correctness of these estimates or as to the alleged ownership by Eaton Co. of certain water rights, we need no such knowledge to perceive that when a firm of engineers of the standing of La Rue and Jakobsen advocates the storage of an additional 51,600 annual acre-feet in Long Valley, the least that the city of Los Angeles can prudently do is to employ consulting engineers to report on this matter. In connection with such a report, again we urge the city to have consulting engineers investigate the water resources of Walker River to the north of Mono basin; for, judging by the runoff reported by the California state engineer, Walker River's supply, added to that of Long Valley and Mono basin, would serve Los Angeles for another generation without going to Colorado River.

None of the Los Angeles papers has reprinted, or even commented upon, our previous editorial articles on this subject, presumably because it has been feared

that the Colorado River project might be postponed if all the facts were known. In Los Angeles that project is commonly looked upon as being one that should not be deferred, because of its supposed value to Los Angeles and vicinity. Because the federal government is financing the Hoover (formerly called Boulder) Dam, the Los Angeles public seems to regard this dam as a gift of Santa Claus. It is a "gift," however, that the recipient must pay for, because the sale of power to the city of Los Angeles and the power companies must not only pay interest on the cost of the dam but amortize the investment in 50 years.

As we have previously pointed out, it is a delusion to believe that power can be developed on the Colorado River and conveyed to Los Angeles at as low a cost as it can be generated there even now by steam. At the recent rate of progress in reducing power costs by steam, before half the 50 years have expired, the cost of power by steam will have been so greatly reduced that the Hoover Dam power project will have become twice as big a white elephant as it now is.

Eventually the Colorado River project should be carried through. "If eventually, why not now?" Simply because the interest on some $400,000,000 can be saved for at least ten years.

Although the effort has been made to conceal the fact, more than half the proposed supply from the Colorado is to be used for irrigation. If this is a wise use, why have no engineering reports been made to show the wisdom of it? The engineering reports throw irrigation, power and domestic use all into one mess, and let the reader try to disentangle the mess if he can. If no other reason existed for employing more consulting engineers, it would be reason enough that their job would be to allocate the proposed investment to its three major uses, and to estimate the annual net income to be expected from each of the three.

The truth is that the citizens of Los Angeles have not been adequately informed as to the Colorado River project. No ballot has yet been taken on any appropriation relative to the project, yet the city has signed a contract with the federal government, engaging to buy the major part of the hydroelectric power that is to be generated at the Hoover Dam. Although legal opinions have been given that the officials of Los Angeles can thus bind the city, we remain skeptical as to their legal right so to bind the city. What, indeed, is the worth of a state charter that prescribes public approval of investment in a public project, if the provisions of the charter can be evaded in this manner? Los Angeles is just as truly investing scores of millions of dollars in the Hoover Dam, when it underwrites most of that investment, as if it sold its own bonds for the purpose. Its city officials have underwritten the investment by signing the power contract with the federal government, and they have done this without a ballot of approval. No "friendly suit" in the California court has yet been brought to settle this phase of the question. Arizona has taken legal steps to stop the whole project, and it seems not unlikely that Arizona will raise the very point that we have just suggested. It may be fortunate for Los Angeles if Arizona succeeds in blocking the project at least long enough to force the city to conduct a thorough investigation of all practicable sources of water supply.

A San Diego hydraulic engineer has proposed that the storage of Colorado River be made in a natural reservoir that lies partly in California and partly in Mexico. A tunnel would deliver the water to the coast, and the pumping lift would be nominal. The project is evidently feasible, and he urges an investigation of its cost. He believes that water may thus be supplied to Los Angeles and southern California at much less cost than by the Hoover Dam project. This suggestion and that of La Rue and Jakobsen, not to mention our suggestion of a Walker River project, alone give sufficient reason why Los Angeles should employ not only one but a score of additional consulting hydraulic engineers to examine every feasible source of water supply.

Marconi Also Advances a Theory of Multiple Electron Shells Surrounding the Earth

EVIDENCE of the existence of shells of electrons around the earth is given in an editorial article on another page; and the theory is advanced that those shells account for the fact that clouds occur in layers that are quite widely separated. In the October issue of "Engineering and Contracting" this electron shell theory is expounded at greater length, and it is shown that both radio echoes and magnetic needle pulsations can be accounted for by the existence of several electron shells, some of which are millions of miles in diameter.

Since these two articles were written by the editor, and after one of them was in type, Marconi, the inventor of wireless telegraphy, has published a theory identical with the one advanced independently by the editor. Before the Italian Society for Advancement of Science, on Sept. 11, 1930, Marconi read a paper in which he said: "The existence of various reflecting layers is the best hypothesis on which to base an explanation of long-distance wave transmission which overcomes the curve of the earth. * * * Radio engineers should, therefore, keep in touch with the work of meteorologists and astronomers, but it is equally useful for the latter to keep in touch with the former, owing to the powerful means which modern developments have placed at the disposal of radio stations."

It was the meteorological researches conducted by the editor during the past three years that led him to frame a definite hypothesis of rain cycles based on the electron theory. Study of the electron theory led the editor to the belief that many other electron shells than the well known Heaviside layer surround the earth. Stormer had found radio echoes that required several minutes for the wave to travel to the point of reflection and back to the earth; but he had ascribed the reflection to streams of electrons coming from the sun, whereas the editor ascribes the reflection to permanent electron shells that surround the earth. The editor also gives facts in "Engineering and Contracting," October, 1930, supporting his theory that similar electron shells surround the other planets and the sun itself.

According to newspaper accounts, Marconi "hinted at the possibility of electric exploration of space." He added that the new under-ten-meter radio waves were apparently reflected from an electron shell much nearer the earth than the Heaviside layer, which is about 43 miles above the earth. And he also said that other observations with radio short waves seem to show similar layers at much greater distances. These statements of his are in perfect accord not only with the facts but with the theory presented by the editor in the two articles written several weeks ago but published this month, October, 1930.

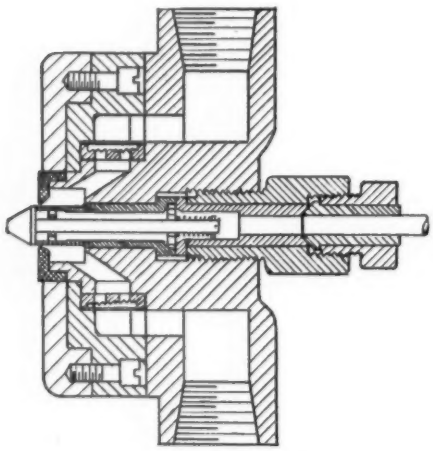
H. P. Gillette

New Equipment and Materials

A New Chlorine Diffusing Device

The Paradon Mfg. Co. of Arlington, N. J., announces the development of a chlorine diffusing device known as the Paradon impulse type dry feed diffusor.

With the impulse type dry feed diffusor, the gas is applied directly to the water or sewage. However, instead of depending on bubbling towards the surface for absorption, a stream of water under high velocity is played on the rising bubbles of gas. This stream is stated to accomplish four purposes: It causes the gas bubbles to take a horizontal path instead of a vertical path, thereby greatly increasing their contact with the water or sewage into which the gas is applied. Second, the high velocity stream minutely divides the bubbles; this action enormously increasing the area of contact between the gas and the water or sewage. Third, the size of the gas bubble being much smaller, its buoyancy is very much less and it therefore will rise to the surface at a slower rate and again more contact with the water or sewage is obtained. Fourth, the high velocity stream of water produces violent agitation of the water or sewage adjacent to the point of gas application; once more effecting a greater contact between the gas and the water or sewage.



The Paradon Impulse Type Dry Feed Diffusor

The manufacturers cite following table of typical results accomplished by the impulse diffusor:

Water Supply (in gals. per min.)	3	4	5
Submergence of Impulse Diffusor (in feet)	Chlorine (pounds per day)		
1	275	350	450
3	350	500	750
5	500	650	750

It is stated that sewage or other liquids could also be used to operate the impulse diffusor, if desirable.

It is further stated that at one installation using impulse diffusors, 200 lb. of chlorine per 24 hours were applied. The water required to operate the diffusor in this case amounted to only 360 gal. per hour.

The impulse diffusor has been in use for approximately one year. Some 25 installations, mostly of medium or large capacity, are now successfully using it.

Klinck Test and Puddle Plug

Harry W. Klinck of Logansport, Ind., formerly superintendent of the Logansport Water Works has procured a patent on a test and puddle plug for use in backfilling the trench where new water mains are laid.

It is customary when laying water mains, to test the joints under pressure before placing the dirt back in the trench. Then after the joints are found to be tight the trench is filled in. If the soil is not tamped in layers as the trench is filled a mound several feet high is usually left over the pipe. Tamping, however, is very expensive and slows up the work considerably.

The test and puddle plug serves two purposes. It is inserted in the end of the pipe and tightened in place. This plugs the pipe and allows the water pressure to be applied for testing the joints. Dirt is then dumped into the trench a few feet behind the end of the pipe to form a dam across the trench. A short piece of 2 in. pipe or hose is coupled into the test puddle plug and water from the main is allowed to fill the trench behind the earthen dam and the soil is dumped into the trench. No tamping is necessary as the soil packs as it is dumped in trench. While the trench is being filled the test and puddle plug may be removed to allow the laying of additional main. By this method the trench may be backfilled as the work progresses and thus eliminate the danger caused from open ditches.

In a comparative test on laying 300 ft. of 6 in. pipe the savings are stated to have amounted to more than the cost of the test and puddle plug.

The Klinck Test and Puddle Plug is being manufactured and marketed by the H. W. Clark Co., Mattoon, Ill.

Cut-In Sewer Connection

A device for connecting a house service with a main sewer pipe without the necessity of placing a Y-branch or T-branch in the line has been placed on the market by The Atlas Mineral Products Co., Mertztown, Pa.

The device is a light cast iron fitting with ball and spigot ends and is made for use with both terra cotta and concrete pipe sewers of all sizes, and for house services of either terra cotta or cast iron pipe of the various diameters usually required.

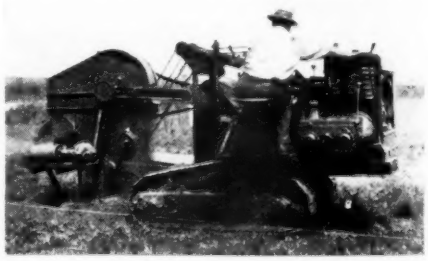
In making use of the cut-in connection a hole of the proper size is cut in the sewer pipe at the required vertical angle, the spigot end of the fitting inserted, a small amount of jute packed in the space between the spigot of the fitting and the rim of the hole in the sewer pipe, and then the cut-in fitting is held rigidly in place by surrounding the outside of the fitting, as far as the base of the bell, and the sewer pipe itself for a short distance on each side of the fitting, with lean concrete or cement mortar applied with a trowel. There is a bead on the spigot end of the cut-in fitting which prevents the jute or concrete from entering the sewer pipe, and the stops or wings on the side of the fitting allow the spigot end to enter the sewer pipe only so far as to be flush with the inner surface of the sewer and thus provide no obstruction to the flow of sewage. The spigot end of the cut-in fittings of the several sizes and types are so shaped as to fit neatly the inside surface of sewer pipes of the various diameters.

New Small Ditcher

A vertical boom ditcher that is only 4 ft. wide and 11 ft. 6 in. long, and when digging is no higher than a tall man's head is the latest achievement of the Barber-Greene Co. of Aurora, Ill.

The new machine—the Service Special Ditcher—has all of the features of the big Barber-Greenes. It is crawler mounted. It has the vertical boom which allows it to dig right up to a sidewalk or curb, ending the trench flush, and to cut a square corner. As an insurance against strains caused by striking underground obstacles and as a protection to any underground pipes, the machine is equipped with the standard B-G overload release sprocket, a device that automatically stops the bucket line without injuring anything or killing the engine. The construction of this sprocket is such that at every half revolution, it exerts a pull on the bucket line before slipping again, and if the operator desires, he can keep the buckets pounding at the obstacle until it is cut through.

The buckets clean themselves automatically, even in very sticky material. Attached to the boom is a telescoping follow-up scraper for insuring a clean trench. The boom is raised by power, making it possible for the operator to dig accurately to grade at all times.



The Service Special Ditcher

The traveling speeds of the Service Special are 2 miles and 1 1/3 miles per hour. Its speed, small size, and crawler mounting make it highly maneuverable. The ditcher is built throughout of heavy structural steel and is powered by a 33 B.H.P. four cylinder Buda gasoline engine.

Five Dump Body Trucks Added to Ford Line

Addition of five dump body trucks to the line of standard Model AA 1½ ton trucks has been announced by the Ford Motor Co.

The Ford dump trucks include an hydraulic dump body with hoist of 1½ tons normal operating capacity; a heavy duty hydraulic dump body; a mechanical dump body; gravity dump body; and hand dump body.

Bodies are made of one piece of steel with no center or bottom seams to interfere with the free flow of materials.

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Power Plant Development Launched by Union Carbide & Carbon Corp.

Construction work is now under way on new hydro-electric and steam electric power plant developments of Subsidiary Companies of Union Carbide and Carbon Corporation, in the vicinity of Hawks Nest, Gauley Junction and Boncar, West Virginia. The total installed capacity of the two plants will be about 200,000 hp. Power output will be utilized by the proposed industrial plant of Electro Metallurgical Company at Boncar.

The hydro-electric power development is being built by New-Kanawha Power Company and is located on the New River, between Hawks Nest and Gauley Junction. It will consist of a dam across New River, an intake, a power tunnel, surge tank, steel penstocks and power house.

The contract for the construction of the dam, tunnel and power house was let to Rinehart and Dennis Company, Incorporated, on March 13, 1930, and work was commenced on March 30. Completion is required and the entire development is expected to be ready for operation by March 13, 1932.

The steam electric power plant is being built by West Virginia Hydro-Electric Company on the Kanawha River immediately adjacent to the site of the industrial plant at Boncar. The contract for its design and construction was let to Ford, Bacon and Davis, Incorporated, on April 15, 1930, and it is expected that it will be finished about July 1, 1931.

The hydro-electric and steam electric plants are expected to provide an average combined annual output of about 120,000 hp.

Mr. O. M. Jones, chief engineer of New-Kanawha Power Company, who is located at Glen Ferris, West Virginia, is in local charge of the hydro and steam plant installations for Mr. L. H. Davis, 30 East 42nd Street, New York, N. Y., vice-president of New-Kanawha Power Company and West Virginia Hydro-Electric Company. Mr. E. H. Mangen is resident engineer in charge of the industrial plant installation for Mr. H. L. Noyes, chief engineer of Electro Metallurgical Company, who is located at Niagara Falls, N. Y. Contract for the erection of the first block of industrial plant buildings has been let to H. B. Agsten and Sons, of Charelston, West Virginia.

Byers Announces Changes in Personnel

H. W. Rinearson, vice-president of A. M. Byers Company has announced several changes in the organization personnel.

H. R. Rowland, division manager at Philadelphia, has been transferred to Pittsburgh as division manager.

E. L. MacWhorter, representing A. M. Byers in western New York, has been promoted to division manager with headquarters in Philadelphia.

Early in October the company will hold a national sales meeting in Pittsburgh. This meeting will be held in conjunction with the official opening of the company's new $12,000,000 plant for manufacturing wrought iron under the Aston patents.

Ground breaking ceremony at Hawks Nest, West Virginia, as steam shovel turned the first bucketfull of earth in the hydro-electric power development now under way for the Union Carbide and Carbon Corporation

News Notes from Paradon

The Paradon Manufacturing Company of Arlington, N. J., announces the appointment of S. S. Williamson as manager of advertising and publicity for the company. Mr. Williamson has spent his entire business efforts in the advertising field and for several years was publicity and advertising manager of the Lidgerwood Company of Elizabeth, N. J.

W. Austin Smith, 1207 Lynch Building, Jacksonville, Fla., has been made sale and service representative for the Paradon chlorinators in Southern Georgia and Northern Florida.

General Engineering and Equipment Company, 704 First National Bank Building, Albuquerque, N. M., has been appointed to represent the Paradon products in the state of New Mexico.

West Virginia will be served for this manufacturing company by Kanawha Equipment, Inc., of Charleston, W. Va.

Announcement

Ray P. Tarbell has recently become a member of the firm of Robert E. Kinkead, Inc., consulting welding engineers, Cleveland, Ohio. He was formerly Cleveland District Sales Manager of The Lincoln Electric Company, manufacturers of Stable-Arc welders and Linc-Weld motors.

Robert E. Kinkead, Inc., serve as welding engineering consultants for large steel companies, steel fabricators and manufacturers of mechanical equipment. They also supervise the establishment of welding departments within industrial firms and direct the methods of welding procedure and control and the redesign of products for arc welded steel construction, a field in which Mr. Tarbell in his former capacity has been actively engaged for many years. As vice president and secretary, Mr. Tarbell will aid Mr. Robert E. Kinkead, well-known authority on welding procedure and control, in his executive duties as president of the firm which bears his name.

Mr. Tarbell, who attended Dartmouth College, entered the employ of The Lincoln Electric Company in 1918.

Shell Chemical Company at Martinez, Cal., is installing E-M Synchronous Motors in the new nitrogen fixation plant to drive air, raw gas, mixed gas and ammonia compressors. All the gas compressors will be equipped with gas-proof enclosures for the collector rings because of the gaseous atmosphere in which the motors are to operate. The control equipment will consist of the E-M full-voltage, automatic controls for synchronous motors. Equipment is furnished by the Electric Machinery Manufacturing Co., Minneapolis.

Tubular Sales Manager for A. M. Byers Co.

Sales activities for the A. M. Byers Company are being departmentalized because of the proposed expansion program looking to the broadening market for the use of wrought iron in forms other than pipe, according to announcement of H. W. Rinearson, vice-president. A newly created position is that of manager of tubular sales which has been assigned to M. J. Czarniecki.

Mr. Czarniecki has been connected with the Pittsburgh, New York and Chicago offices of Byers, and has served them continuously, with the exception of the period of the war, since 1913. Since 1925 he has been serving as assistant general manager of sales with headquarters in Pittsburgh.

Burton Explosives Enters Manufacturing Field

Concurrent with the filing of a deed covering 418 acres of land near New Castle, Pa., announcement is made of the entry of Burton Explosives, Inc., hitherto a sales organization, into the explosive and chemical manufacturing field.

J. S. Burton, president and general manager, formerly president of The Grasselli Powder Company, is quoted as stating that an initial production of 12,000,000 pounds of high explosives in 1931 is projected.

A plant to employ over one hundred men is now under construction on the site of the former American High Explosives Company, of which Mr. Burton was general manager at the time of a merger of The Burton Powder Company with Grasselli in 1917.

Manufacture of a line of heavy chemicals is proposed as a development to follow the establishment of the explosive line.

Headquarters of the company are in the Guardian Building, Cleveland, Ohio.

Production is scheduled to start January 1, 1931.

X-Ray Plant Installed for Babcock & Wilcox

The St. John X-Ray Service Corporation, 505 Fifth Avenue, has installed what is said to be the first X-Ray plant of its kind in the Barberton, Ohio works of the Babcock & Wilcox Company.

The photographic apparatus will be used primarily for routine inspection of welded seams in pressure vessels, heat exchangers and similar equipment.

Dr. Ancel St. John, president and technical director of the company which bears his name, says that the Babcock & Wilcox X-Ray plant is certainly the first of its kind and in all probability, the most powerful as well.

Westinghouse Promotes T. R. Langan

C. E. Stephens, vice president, Westinghouse Electric and Manufacturing Company has announced the appointment of T. R. Langan as assistant northeastern district manager of the Westinghouse organization.

Mr. Langan has been with the Westinghouse Company for more than twenty years. Starting as an apprentice he advanced to the office of manager of the transportation division of the northeastern district, which office he held at the time of his promotion. He has been identified with the major high voltage A.C. railroad electrifications in the United States, and when the New York, New Haven & Hartford Railroad system was electrified, Mr. Langan acted in a supervisory capacity on this installation for seven years.

T. R. Langan

Before coming to the New York office, Mr. Langan served the Westinghouse Company in Philadelphia, Baltimore, Buffalo and was manager of the Syracuse office.

Mr. Langan will make his headquarters at New York and will continue to function as manager of the transportation division of the northeastern district.

Link-Belt Transfers MacNeal to Birmingham

B. H. MacNeal, who has been with the Link-Belt for a number of years, has been appointed Southern District Manager of the crane-shovel-dragline division. He has had a broad experience both at factory and in the field, with the complete line of Link-Belt products.

Mr. MacNeal will have charge of the territory between the Mississippi Valley and the east coast, south of and including the states of Tennessee and North Carolina, and will maintain headquarters at the company's Birmingham office.

Electricity Did It

Forty seconds for wood pulp and water to pass through approximately ten individual machines and come out a sheet of paper ready for the printer's ink, is the time specified by E. L. Manning of the Research Laboratory of the General Electric Company. Just one more debt of gratitude that the public owes to the power of electricity.

Mr. Manning is presenting a series of sketches outlining various research and engineering achievements of the electrical industry, which are being broadcast over W G Y.

The Independent Pneumatic Tool Company, 600 West Jackson Boulevard, Chicago, has appointed the Mine and Smelter Supply Company, Salt Lake City, Utah, as their agent. This company will handle a complete line of Thor Pneumatic and contractor tools in their territory. They have branch offices in Denver and El Paso.

Keystone Portland Cement Elects Scott President

Announcement has been made by the Keystone Portland Cement Company of the election of Harold M. Scott as president to fill the vacancy caused by the death of the former president, John Barnes.

Although Mr. Scott may be considered one of the younger men in the industry, his experience covers a period of 25 years. He has been connected with the Lehigh, Edison and Atlas Portland Cement Companies. He was general sales manager of the Atlas company, and according to report will adopt a policy of aggressive operation for Keystone.

Construction of the two additional kilns, grinding equipment and storage facilities, which were inaugurated about a year ago at the Bath, Pennsylvania, works of Keystone have been practically completed, which is said to make this plant one of the largest single units in the Eastern territory.

Hercules Powder Makes Personnel Changes

Mr. C. C. Gerow, director of sales of the Hercules Powder Company of Wilmington, Delaware, has announced the appointment of J. H. Horlick, Jr., as assistant director. Mr. Horlick has served for a number of years as manager of the service division. He will take over the duties of the late Fred F. Smith.

J. Barab will become new service division manager, and H. M. Lynch will continue to act as chief clerk and as assistant to Mr. Horlick, according to announcement.

Changes in Boston Office Of Penn-Dixie Cement

According to recent announcement, H. E. Bernt has been appointed district sales manager of the Boston office of the Pennsylvania Dixie Cement Corporation. He takes over the office held by E. G. Brick, who, according to report, asked to be relieved of the responsibilities in connection with it and will thus be able to make more frequent contacts with the trade.

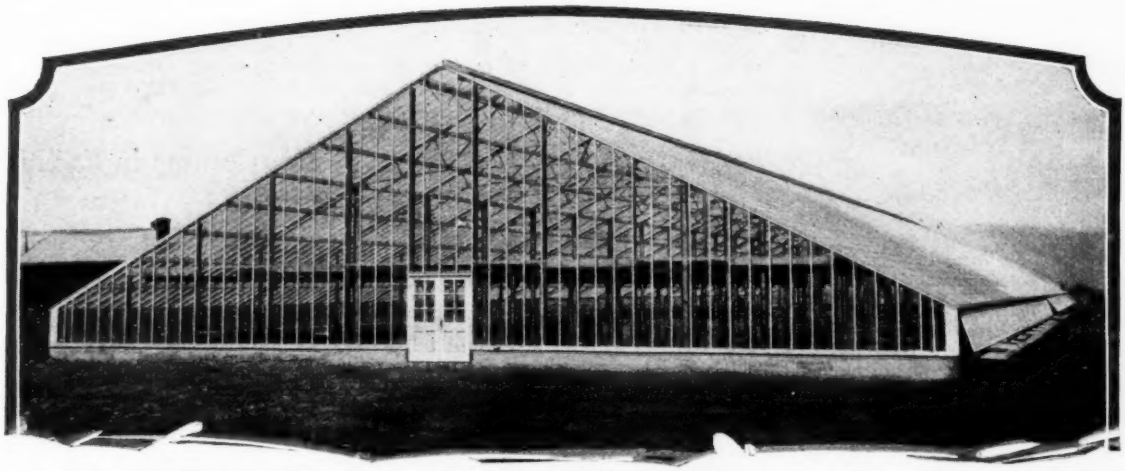
Mr. Bernt is familiar with the territory and its requirements as for some time past he has been assistant district sale manager.

The position of assistant district sales manager of the Boston office will be filled by R. M. Penman, who has recently joined the Penn-Dixie organization. Mr. Penman has been connected with a leading cement manufacturer for the past 21 years.

Hercules Powder Executives Attend European Meeting

George M. Norman, technical director of the Hercules Powder Company, and A. B. Nixon, general manager, Cellulose Products Department, left recently for Europe where Mr. Norman will attend the International Cellulose Conference at Liege, Belgium. Mr. Nixon will survey the market for American collodion cotton in Germany and other countries.

Service Exchange Department is to assist in building up strong distribution organizations. Use it.



Moore erects all-steel glass sludge bed enclosures for City of Dunkirk

Since 1869

THE Moore Construction Co. of Buffalo, New York, have just completed the erection of two American-Moninger all-steel acid resisting glass sludge bed enclosures for the City of Dunkirk, New York. One house is 74 feet wide by 125 feet long and the other is 74 feet wide by 250 feet long. Frederick K. Wing Company of Buffalo, New York, were the engineers.

These houses were designed and built with heavy overhead beams arranged for carrying the Louden Buckets used in sludge bed work.

Benefit from American-Moninger's experience in sludge bed work and get preliminary plans, specifications and estimates from American-Moninger before you build. No obligation on your part.

American-Moninger Greenhouse Manufacturing Company

SOUTHWEST OFFICE
2611 North Dewey St.
Oklahoma City, Okla.

1365 Flushing Avenue
Brooklyn, New York

WESTERN OFFICE
1313 W. Randolph Street
Chicago, Ill.

No Water Hammer—No Bursted Mains

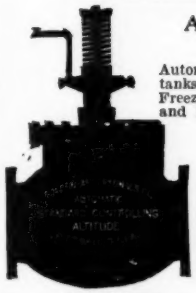
GOLDEN-ANDERSON

GOLDEN-ANDERSON
Patent Automatic Cushioned Controlling Float Valves

Adapted to automatically maintain a uniform water level in feed-water heaters, tanks, reservoirs, and pans. Very sensitive.

Operating on ½-inch to ¾-inch variation. No exhaust or expensive water waste. Can be furnished for hot or cold initial water supply. Reliable and dependable under varying pressure.

Sizes ½-Inch to 24 inches



Automatic "Cushioned" Controlling Altitude Valves Cushion All Water Surges

Automatically maintain a constant stage of water in reservoirs, tanks and standpipes. They do away with the annoyances of Freezing Valves and Float fixtures inside of the Tanks or Floats and Fixtures outside of Tanks.

"Three Ways of Closing These Valves":
1st—Automatically, by water.
2nd—By electricity, if desired.
3rd—By hand.

May also be arranged to close automatically when a break occurs in the mains. When necessary they may be so connected as to "work both ways" on a single line of pipe. The double cushion effect of air and water eliminates water hammer. There are no dangerous surges to burst water mains. Write for details.

REMEMBER
Valves cushioned at all times by air and water. No water hammer or bursting mains.

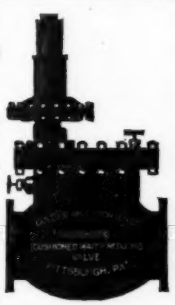
"Made with stop starter attachment for centrifugal pumps."

GOLDEN-ANDERSON VALVE SPECIALTY COMPANY
1329 Fulton Bldg., Pittsburgh, Pa.

GOLDEN-ANDERSON
Patent Cushioned Water Relief Valves

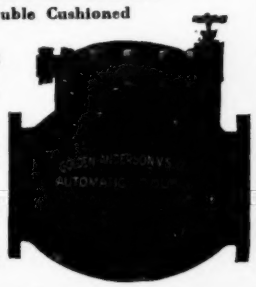
1. Automatically relieve excess pressure.
2. Prevent stress, strain and bursting of mains.
3. Correct mechanical construction.
4. Perfect air and water cushioning.
5. No metal-to-metal seats. No hammering or shocks.
6. Angle and globe pattern. Sizes 3 to 24-inches.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Pressure Regulating Valves



1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.

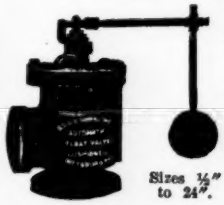
GOLDEN-ANDERSON
Pat. Automatic Double Cushioned Check Valves



1. Especially adapted for water service.
2. For high or low pressure.
3. Thoroughly cushioned. No chattering, hammering, or sticking.
4. Globe or angle patterns up to 24 inches.
5. Especially adapted for hydraulic elevator service.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Float Valves

1. Automatically maintain uniform water levels in tanks, standpipe, etc.
2. Instantly adjusted to operate quickly or slowly.
3. Floats swivel to any angle—most satisfactory float valves known.
4. No metal-to-metal seats—no water hammer or shock.
5. Cushioned by air and water.



Sizes ½" to 24".

Cast Iron Pipe Co. Hold Open House at Denver

In celebration of the opening of the new office of the Pacific States Cast Iron Pipe Company in Denver, "open house" was held October 3rd and 4th in Room 226, Continental Oil Building, Eighth and Glenarm Street.

The celebration took the form of informal discussions of water works problems and exhibits of McWane-Pacific cast iron pipe.

Dana E. Kepner is manager of the Denver office, which will serve Wyoming, Colorado and New Mexico. A complete stock of McWane-Pacific products will be available at Denver for territory covered.

General offices and foundries of the Pacific States Company are located at Provo, Utah.

Permutit Buys Zeolite Water Softening Apparatus

The Paige and Jones Chemical Company announces that it has sold to The Permutit Company the Zeolite and Lime Soda Water Softening and Filter Departments of its business including machinery, inventories, patterns and drawings relating thereto. It has been manufacturing Zeolite water softening apparatus as licensee under The Permutit Company's patents. The Permutit Company with its large engineering staff will be in a position to furnish repair parts and replacements for Paige-Jones mechanical equipment now in use. The Paige and Jones Chemical Company will continue the chemical branch of its business in which it has held a prominent position for the past sixteen years.

Penn-Dixie Announces Promotions

B. W. Druckenmiller, who for the past two years has been sales manager of the Pennsylvania-Dixie Cement Corporation, has been appointed assistant general sales manager, with headquarters at 521 Fifth Avenue, New York, according to recent announcement. Before joining Penn-Dixie Mr. Druckenmiller was connected with the Crescent Portland Cement Company, Wampun, Pa., for approximately sixteen years.

F. J. Selinger, who became associated with the Penn-Dixie organization some months ago, has been appointed sales manager. For twenty-three years Mr. Selinger was connected with the Portland Atlas Cement Company before joining the firm with which he is now associated.

Benefit by Pension Plan

Full pension benefit for their whole period of continuous service with the former Atlas Portland Cement Co., whose properties, assets, and business were acquired by the United States Steel corporation in January, will be extended to Atlas workers now continuing with the Universal Atlas Cement Co., a U. S. Steel Corporation subsidiary. This decision, according to recent announcement by the Universal Atlas Company, places in line for pension benefits approximately 4000 former Atlas employees, many of whom thus get credit for twenty-five or more years of work with the former firm.

The United States Steel Corporation pension fund, introduced in 1910 by the corporation and Andrew Carnegie jointly, was one of the first general pension plans established in American industry. Its benefits are apportioned according to a sliding scale based on wages and length of service. The new ruling means that former Atlas men will receive pension credit for continuous service including not only the period since January, but all continuous service with the former Atlas company.

The pension plan involves the retirement of men who have served twenty-five years or more, usually at age of seventy; by request, at sixty-five or thereafter; and at any age, through permanent incapacity.

Haynes Stellite Company Opens New Foundry

Haynes Stellite Company, Kokomo, Ind., a unit of Union Carbide and Carbon Corporation, has announced the completion of a new foundry at the Kokomo Works, which has been built expressly for the manufacture of the Hastelloys, a group of new acid resistant alloys. It is stated the most up-to-date and efficient foundry equipment procurable has been installed to insure careful control of quality and uniformity of product.

The Hastelloys form a group of corrosion-resistant alloys of interest to chemical engineers, and others who have been faced with the problem of providing suitable equipment for resisting the action of hydrochloric acid and moist chlorine. Hastelloy "A" resists the action of both hot and cold hydrochloric acid, while Hastelloy "C" resists the action of wet chlorine.

The production of these alloys, facilitated by the opening of this new foundry, will be of interest not only to the chemical and process industries but to all industries in which the handling of acids is a problem.

An October Date

The semi-annual meeting of the Concrete Reinforcing Steel Institute will be held from October 20 to 22, at Briarcliff Lodge, Westchester County, New York.

The American Iron and Steel Institute is to meet in New York City October 24, so members and guests may thus kill two meetings with one railroad trip.

The principal address of the opening session of the Reinforcing Institute will be made by Mr. James G. Lewis, eastern manager of the Scripps-Howard Newspapers, New York City. The subject as announced is "Where Selling Should Stop."

The committee in charge of arrangements for the Institute will provide cars for guests to motor along the Hudson River to West Point, Bear Mountain Bridge and other nearby points of beauty.

Representation on the Florida coast has been secured for the Institute through the recent election of D. F. Taylor, Inc., of Tampa, to membership, according to recent announcement.

The City of Chicago received some very interesting publicity (not a word about shooting) in the lead-off article on The Development of a Great Utility, which appeared in the September issue of The U. S. Piper, the monthly paper published by the United States Pipe and Foundry Company of Burlington, N. J. Mr. Ralph M. Shaw, Jr., is the editor of this interesting and attractive monthly.

Distributors in Far Northwest Over Twenty Years

The B. C. Equipment Co., Vancouver, B. C., who have recently taken on the distribution of McCormick-Deering tractors and the Trackson line of Crawlers, Shovels, Cranes, Hoists, etc., are one of the oldest eqiupment firms in the Dominion. They have been in business in British Columbia for more than twenty years and are well known to the equipment industry in the United States, as well as in Canada.

At the head of the B. C. Equipment Co. are S. J. Crocker, manager; F. A. Dietrich and G. W. Tornroos, who together organized the company and are still actively engaged in its operation. Another veteran equipment man, Norman C. Cruikshank, is the manager of their tractor and equipment department.

In addition to their main offices and showrooms at Vancouver, they also have a large warehouse and shop in the city, and a branch office at Nelson. A staff of thirty is employed at Vancouver and three men work out of the Nelson office.

These distributors are in close touch with highway and other government and municipal officials, contractors, the mining industry, loggers, etc., and are finding a very big field for the lines they represent.

In addition to the International Harvester Co. and The Trackson Co., they represent the Gardner-Denver Co., Climax Engineering Co., DeLaval Steam Turbine Co., Dominion Road Machinery Co., Ransome Concrete Machinery Co., London Concrete Machinery Co., Petters, Ltd., of England, Northwest Engineering Co., S.K.F. Steels, Inc., Sweden, and other well-known manufacturers.

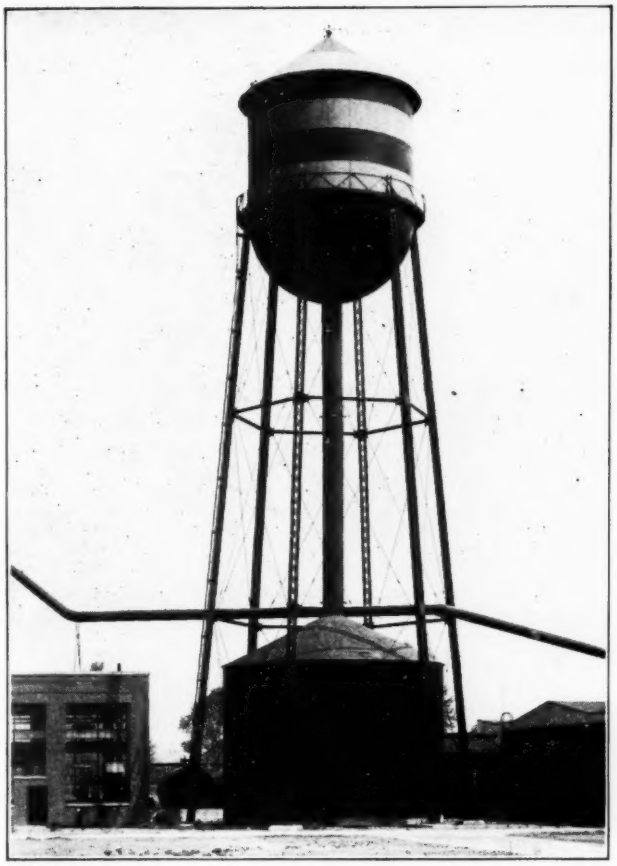
Traffic Will Be Served

The famous Tennessee Pass highway in Colorado, 10,240 feet above sea level, was kept open throughout the entire last winter for an average daily motor traffic of 100 cars. This is thought to be the first time such a record was ever maintained. Crews at times worked at a temperature of 36 degrees below zero.

Chicago Mill and Lumber Corporation announces the appointment of M. C. Jensen as successor to W. H. Badeaux in the company's northwest district with headquarters in the Foshay Tower, Minneapolis. Mr. Jensen was until recently supervisor of Weatherwild sales in the New York zone for the company he represents. Mr. Badeaux has joined Simmons Millwork, Inc., of Minneapolis.

Service Exchange has been helpful in securing desirable representation for the products of many manufacturers and in assisting distributors in building up their lines. Do not hesitate to make use of this service which the publishers present as a regular feature of this magazine. For information write, Editor, Distributor News.

PITTSBURGH DES MOINES



The 200,000 gallon PDM Elevated Tank on a 100 foot tower gives reliable fire protection to the Fisher Body Corporation plant at Seattle, Washington. The ground suction tank is also of 200,000 gallon capacity

The Elevated Tank Supplies the Pressure The Ground Tank gives the Reserve Supply

Last summer's seven weeks' drought taught municipal and industrial officials many things about water supply. Two fundamental requirements are *Pressure* and *Reserve Supply*. Each complements the other; each alone is not adequate.

Pittsburgh-Des Moines Elevated Steel Tanks today guarantee the required water pressure in all parts of the United States. Pittsburgh-Des Moines Ground Tanks and Steel Standpipes up to 3,000,000 gallons supply the necessary reserve supply to maintain this pressure during fire, drought, repairs, or other emergencies.

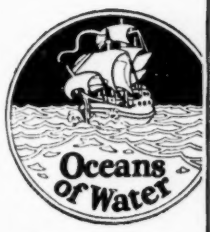
Thirty-three years' contracting experience in the municipal and industrial fields qualify PDM engineers and tank builders to design and erect your water supply equipment.

PDM Engineers will gladly cooperate with you in applying the economics of modern water storage and supply to your problem. Write today for our Tank and Tower Folder No. 2 giving detailed drawings and measurements of a standard PDM tank and Tower

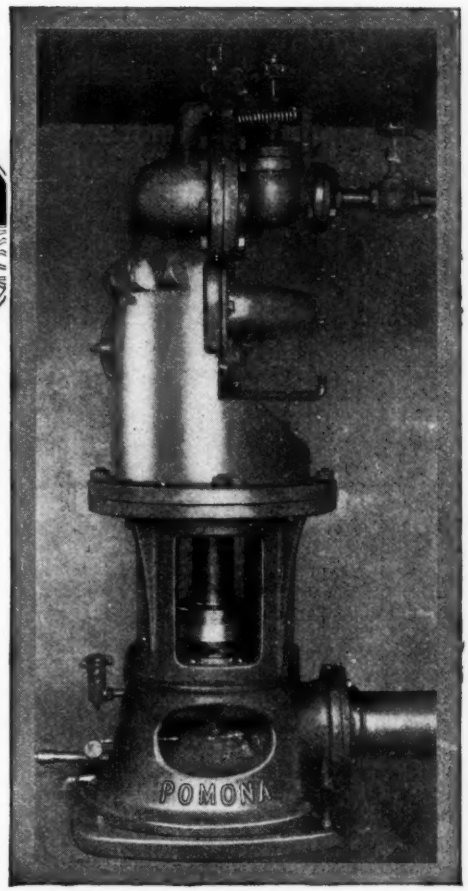
Pittsburgh-Des Moines Steel Company

3404 Neville Island, Pittsburgh, Pa.
906 Tuttle St., Des Moines, Ia.

New York Chicago Dallas Atlanta
Seattle San Francisco



Pomona Water-Lubricated Turbine Pumps are readily adapted to any prime mover. Photo at right shows a Murray Vertical Steam Turbine mounted on Pomona pump head.



Pumping Water economically with Steam or Electricity

Hundreds of satisfied WATER WORKS ENGINEERS are using Pomona Water-Lubricated Turbine Pumps exclusively. They have proven to themselves that our claim to cleanest water, more economically produced, is based on facts. In your vicinity there are Pomonas operated by many different methods; direct connected electric motors of any current characteristic, belted heads driven by tractor, steam engines, horizontal motors, etc. In many plants, where steam is available, vertical steam turbine drive is well suited. Constant attention or trained engineers are not required to operate the Pomona Water-Lubricated Turbine Pump.

Factory representatives, sales and service offices in all principal cities. Name of nearest one and Bulletin on request.

Pomona Pump Co , Pomona, Calif.

POMONA

WATER-LUBRICATED TURBINE **PUMPS**

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives of their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Manufacturers' agents representing well known lines of water works equipment desire to secure line of pipe pushers and other similar equipment for California and western Nevada territory.

Distributor covering northern California, having warehouse facilities, would like to secure line of water meters, pipe jacks or pushers, flow meters, and sewage treatment and disposal material and equipment.

Canadian distributor of equipment for water softening, filtration, sewage purification and pumping is interested in securing exclusive sales rights for kindred equipment in the Dominion.

West Coast distributor, specializing in materials for sewers and water works, is in a position to render splendid representation for territory covered.

Manufacturer's representative, with warehouse facilities available, would like to secure additional lines in water works and sewerage and general contracting fields. Covers Houston and San Antonio territory.

Wanted for Buffalo, Niagara Frontier and Western New York territory a good power and heating boiler account.

Manufacturer's representative now handling centrifugal pumps would like to secure other lines in water works field. Covers eastern Pennsylvania, south Jersey and Delaware.

Water Works equipment distributor, covering northeastern Indiana, would like to secure representation of a line of chlorinators.

Manufacturers' agents representing well known lines of water works equipment desire to secure line of pipe pushers and other similar equipment for California and western Nevada territory.

Distributor covering northern California, having warehouse facilities, would like to secure line of water meters, pipe jacks or pushers, flow meters, and sewage treatment and disposal material and equipment.

West Coast distributing organization equipped to take on additional lines of equipment and supplies for water works and sewerage field.

Water works equipment distributor, covering northeastern Indiana, would like to secure representation of a line of chlorinators.

Distributor covering Wisconsin and Illinois territory wishes to add to present lines. Thoroughly familiar with bituminous materials and equipment for handling.

Wanted line of street markers or other traffic equipment on exclusive basis by distributor covering New Jersey and New York territory.

Warehouse facilities for serving Pittsburgh territory. Would like to secure line of portable and stationary conveyors.

Representative in Northwest desires to handle, on commission basis, line of road building and maintenance machinery, revolving scrapers, tractors, rotary snow plows and V push plows.

Good, unassigned territory available for distributors and manufacturer's representatives to handle paving expansion joint line.

Diesel engine account, road building material and equipment line, and industrial equipment and materials seeking representation in south wanted by Florida distributor. Large warehouse facilities.

▼

Representatives Wanted

Manufacturer of non-clogging sewage pumps, both horizontal and vertical, as well as water works pumps suitable for municipalities of 50,000 or 60,000 people, is interested in securing additional sales representation.

District representatives wanted for sanitary engineering specialty used extensively in the water works, sewage and swimming pool fields.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

Distributors wanted for deep-well turbine pumping unit. Product serves small industrial plants, private estates and farmers.

Manufacturer of water works brass goods would like to make proposition to manufacturers' representatives calling on water works' trade.

Manufacturer of centrifugal pumps for water works, sewage plants, sand and dredging plants, process industry, contractors, etc., desires to secure additional representation. Attractive territory available.

Manufacturer of special valve and hydrant lubricant wishes to establish distributing points throughout the country.

Eastern manufacturer of grade-rippers, scrapers and road hones has desirable territory open for distributors.

Manufacturer of patented luminous highway danger signs and signals is interested in securing aggressive representation in various parts of this country and Canada.

California territory available for distributor wishing paving expansion joint account.

Southwest and Middlewest distributors wanted by manufacturer of metal lath, corner beads, channels and reinforcing mesh.

Manufacturer of complete line of construction equipment, mixers, saw rigs, plaster and mortar mixers and pumps has an open territory in the state of Maine and is looking for an aggressive distributor to represent him there.

Long established and well-known manufacturer of industrial locomotives wishes to make contacts with qualified distributors. Locomotive line includes steam, gasoline, gas-electric and oil-electric. Supported by national trade journal advertising.

Manufacturer of patented reflecting signs and devices desires representative for New York City, Long Island, Westchester County and adjacent territory. Some one selling other products to municipalities preferred.

Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Attractive territory open in states south and west of Chicago by manufacturer of cut to length, easily erected standardized steel highway bridges, for spans up to and including 40 ft. Product sells to highway commissioners and superintendents.

Manufacturer of Transverse Testing Machines desires to build up distribution organization in this country and abroad.

Several desirable states open. Wanted distributing organizations covering entire states by manufacturer of mechanical spreader.

Territory open in several states for representatives to handle grade-rippers, scrapers and plows.

Open territory in New York and New England states for aggressive distributor wishing to take on line of hoisting machinery and air compressors.

Manufacturer of air compressors and contractors' tools has number of desirable territories open. Full co-operation will be extended to distributors.